ORIGINAL ARTICLE

Upper limb reconstructive surgery uptake for persons with tetraplegia in New Zealand: a retrospective case review 2001–2005

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Study design: Retrospective case series.

Objective: To describe the uptake of upper limb surgery by individuals with tetraplegia in New Zealand (NZ).

Setting: New Zealand.

Methods: The clinical notes of all individuals who sustained a cervical spinal cord injury between 1 January 2001 and 31 December 2005 were retrospectively reviewed for those who met the clinical criteria to undergo upper limb surgery. Cases were cross-referenced to the hand surgery record to determine the uptake of upper limb surgery in this cohort.

Results: The uptake of upper limb surgery for people with tetraplegia in NZ was 44% of the eligible cohort and 59% of those assessed for surgery. This is notably higher than the reported proportion in other developed countries. The data also suggested that women and those who identified as NZ Maori were less likely to undergo upper limb surgery than were men and those of NZ European ethnicity.

Conclusion: Utilization of upper limb surgery in the eligible tetraplegic population in NZ was high. However, it seemed that some groups were less likely to undergo surgery. Further research into the factors that affect an individual's decision to undergo upper limb surgery could explain the observed pattern.

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Keywords: tetraplegia; hand surgery; utilization

Introduction

Impairment of the upper limb after cervical spinal cord injury (SCI) causes a loss of independence in basic daily tasks, such as grooming, eating, drinking and communication. Individuals with tetraplegia desire improved upper limb function above all other lost functions, including bowel, bladder and sexual function and ambulation.¹ Surgical procedures to improve elbow extension, pinch and finger grasp in people with tetraplegia are performed in many centres. The benefits of these procedures are acknowledged by both surgeons and people with tetraplegia as improving function and independence with activities of daily living.² Experts in this field estimate that more than half of the tetraplegic population could benefit from some form of upper limb surgical procedure.^{3,4} Uptake of upper limb surgery is variable and in the United States, an

estimated 7% of the eligible population undergo surgery.^{5–7} One of the most commonly cited reasons for low utilization is the lack of clarity in the existing literature about the value of the procedures performed and the lack of evidence of effect for different surgeries. This makes it difficult for physicians and health professionals to summarize useful information from the literature for patients and even more difficult for patients to find this information for themselves.^{2,7}

There is a paucity of data on SCI in New Zealand (NZ) because of the lack of a national SCI register, although it seems the rate of SCI in NZ men is three times higher than in women and in men between 15 and 29 years accounting for 46% of all SCI cases.⁸ Motor vehicle accidents and falls account for the majority of injuries.⁹ These few data are similar to worldwide trends with motor vehicle accidents in the 15–44 years age group being the most common cause of SCI, followed by falls in the >60 years age group.^{10–12}

Upper limb surgery has been performed in NZ for more than three decades, based at one (Burwood Spinal Unit (BSU)) of the two (BSU and Auckland Spinal Rehabilitation

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Unit (ASRU)) NZ spinal units.¹³ All eligible cervical SCI individuals are routinely referred to the hand surgery team by the spinal physicians from both units 12–18 months after injury for assessment. When a decision for surgery is made, usually simultaneous bilateral procedures are performed, either deltoid to triceps procedures or forearm tendon transfer procedures. This has the advantage of reducing surgery as well as rehabilitation times and costs, but does result in an increased burden of care after surgery as both arms are immobilized concurrently. The length of in-patient stay is dependent on the surgical procedure performed. In general, deltoid to triceps transfer requires a 12-week in-patient admission, whereas patients undergoing forearm tendon transfer surgery spend 3 weeks at home while their arms are immobilized in plaster, then return for a 14-day in-patient rehabilitation period. All upper limb surgical procedures performed in NZ are fully publically funded.

Anecdotally, NZ has greater utilization of upper limb surgery than that reported in the United States. Neither the uptake of upper limb surgery nor the demographics of people electing to undergo upper limb surgery performed in NZ have been investigated previously.

Materials and methods

A retrospective case series was undertaken in both NZ spinal units (ASRU and BSU) of individuals who sustained a cervical SCI between 1 January 2001 and 31 December 2005. Cases were included if the clinical records showed a cervical SCI between C4 and C7; if medically stable with no complications of SCI such as renal stones, deep vein thrombosis or pressure areas that would affect suitability for general anaesthesia or post-operative recovery; and if the clinical criteria for upper limb surgery were met. Those cases that were under 16 or over 70 years of age (because those aged under 16 or over 70 years are not offered surgery); or those that had an upper limb pathology that would prevent surgery being performed such as rheumatoid arthritis, brachial plexus or nerve injury or previous fractures affecting range of movement or functional use of the arm were excluded.

Demographic information was collected from clinical records, computerized Patient Management System and the hand surgery file and thereafter entered into an Excel Spreadsheet (Microsoft Corporation, Redmond, WA, USA) and transferred into SPSS (Version 15.0, SPSS Inc, Chicago, IL, USA) for analysis. Population was described using means with s.d. for continuous data, and proportions for ordinal and nominal data. Differences between the demographics of the surgery and the no-surgery group were tabulated and investigated using χ^2 tests for non-parametric data. The level of significance was set at $P < 0.05$.

Results

Between 1 January 2001 and 31 December 2005, a total of 217 individuals sustained an acute injury at C4, C5, C6 or C7 and were discharged from a spinal unit in NZ (115 ASRU, 102 BSU). Once clinical notes were screened, there were 61 cases

Table 1 Demographic variable by spinal unit

Variable	Total (n = 61)	ASRU (n = 32)	BSU (n = 29)
<i>Age</i>			
Mean age, years (s.d.)	32.9 (15)	32.8 (16)	33.0 (14)
Range, years	16–65	16–65	16–56
<i>Gender</i>			
Male	46	27	19
Female	15	5	10
<i>SCI level</i>			
C4	3	3	0
C5	15	9	6
C6	37	17	20
C7	6	3	3
<i>ASIA classification</i>			
ASIA A	38	19	19
ASIA B	7	4	3
ASIA C	9	5	4
ASIA D	7	4	3
Mean in-patient stay, weeks (s.d.)	23 (8)	22 (7)	25 (8)
<i>Marital status</i>			
Partner	19	13	6
No partner	41	18	23
Unknown	1	1	0
<i>Ethnicity</i>			
NZ European	37	18	19
NZ Maori	14	8	6
Cook Island	3	3	0
Samoan	1	1	0
Tongan	2	1	1
Other	4	1	3
<i>Employment status</i>			
Employed	40	18	22
Not employed	15	8	7
Unknown	6	6	0

Abbreviations: ASRU, Auckland Spinal Rehabilitation Unit; BSU, Burwood Spinal Unit; NZ, New Zealand; SCI, spinal cord injury.

that met the inclusion criteria (32 ASRU, 29 BSU) for this study.

Demographics and injury characteristics

The demographics of the study population by the spinal unit are presented in Table 1. Cervical SCI in NZ between 2001 and 2005 was most common in the 17–25 years age groups (data not shown).

Ethnicity

About two-thirds of the study population ($n = 37$, 62%) identified themselves as NZ European, whereas nearly one-quarter ($n = 14$, 23%) identified themselves as NZ Maori. No obvious differences in ethnicity between the two spinal units were noted.

Assessment for upper limb surgery

Three-quarters of 61 cases ($n = 45$, 74%) had been assessed for upper limb surgery at the time of study. Of the remaining 16

people who had not been assessed, there was a proportionately high number of Maori ($n=9$) and women ($n=6$). Of the six women, four were also Maori. Approximately half those with ASIA C—incomplete SCI ($n=4$)—or C5 SCI level ($n=8$) had not been assessed for surgery at the time of data collection (Table 2).

Utilization of upper limb surgery in NZ

In all, 2 of the 61 people in the study population died after discharge from the spinal units, 1 from each unit.

Table 2 Demographic variables of people assessed and not assessed for upper limb surgery

	Total ($n=61$)	Not assessed, ($n=16$)	Assessed, ($n=45$)
<i>Gender</i>			
Male	46	10	36
Female	15	6	9
<i>SCI level</i>			
C4	3	0	3
C5	15	8	7
C6	37	7	30
C7	6	1	5
<i>ASIA classification</i>			
ASIA A	38	9	29
ASIA B	7	2	5
ASIA C	9	4	5
ASIA D	7	1	6
<i>Marital status</i>			
Partner	23	3	20
No partner	37	12	25
Unknown	1	1	0
<i>Ethnicity</i>			
NZ Maori	14	9	5
NZ European	37	6	31
Tongan	2	1	1
Cook Island/Maori	3	0	3
Samoan	1	0	1
Other	4	0	4

Abbreviations: NZ, New Zealand; SCI, spinal cord injury.

One individual had been assessed and was on the waiting list for surgery and the other had not been assessed. Thus, the analysis of surgical uptake was completed for 59 cases. Figure 1 shows the configuration of the surgery and no-surgery groups. The uptake of upper limb surgery was 44% (26 of 59); this is 59% of those assessed for surgery (26 of 44).

Surgery versus no-surgery group

Differences were observed in gender, ethnicity, employment and marital status between the two groups (Table 3). With regard to gender, equal numbers of men chose to either undergo surgery or not, whereas 3 women underwent surgery compared with 11 who did not. Differences were also observed in ethnicity. Three-quarters of individuals who underwent surgery identified as NZ European ($n=19$), and only 12% ($n=3$) identified as NZ Maori. In contrast, one-third of the no-surgery population identified as NZ Maori ($n=10$). Similar numbers of individuals from Cook Island and Samoa are seen in the surgery 12% ($n=3$) and the no-surgery 9% ($n=3$) groups. Those who were not employed at the time of injury were less likely to undergo surgery ($n=4$) than those who were employed ($n=20$). Finally, two-thirds of the people who did not undergo surgery did not have a partner ($n=22$), whereas there were similar proportions of people with partners in the surgery ($n=13$) and no-surgery ($n=10$) groups.

No statistically significant difference was noted between the surgery and no-surgery groups for gender, ethnicity, marital status or employment status (Table 4), but NZ Maori and women were underrepresented in the surgery population. The odds ratios and confidence intervals suggested that there could be an important clinical difference in the uptake of upper limb surgery; it is possible that the odds of not undergoing surgery could be up to 15 times greater if one is a woman or Maori (compared with being a man or non-Maori, respectively).

In addition to these demographics, no clear differences between the surgery and no-surgery groups for mean age, spinal unit, ASIA classification or employment status were

Figure 1 Surgery and no-surgery groups.

noted. The average length of time between injury and surgery for those who underwent surgery was 20 months (s.d. 10 months).

Table 3 Comparison of surgery with no-surgery group

Demographics	Surgery (n = 26)	No surgery (n = 33)
<i>Age (years)</i>		
Mean age	36	31
s.d.	15	14
<i>Gender</i>		
Male	23	22
Female	3	11
<i>Spinal unit</i>		
BSU	12	16
ASRU	14	17
<i>SCI level</i>		
C4	3	0
C5	6	8
C6	14	22
C7	7	3
<i>ASIA classification</i>		
ASIA A	17	20
ASIA B	3	4
ASIA C	3	5
ASIA D	3	4
<i>Marital status</i>		
Partner	13	10
No partner	13	22
Unknown	0	1
<i>Ethnicity</i>		
NZ European	19	19
NZ Maori	3	10
Cook Island/Samoan/Tongan	3	3
Other	1	1
<i>Employment</i>		
Employed	20	19
Not employed	4	10
Unknown	2	4

Abbreviations: ASRU, Auckland Spinal Rehabilitation Unit; BSU, Burwood Spinal Unit; NZ, New Zealand; SCI, spinal cord injury.

Discussion

This study showed that the utilization of upper limb surgery in the tetraplegic population of NZ was high with 44% of the eligible population and 59% of those who were assessed electing to undergo surgery. This is higher than the reported utilization of 7% in the United States.⁵ However, there are 16 cases of the 59 surviving individuals in the cohort that were not assessed at all for upper limb surgery, despite meeting the clinical criteria for surgery. As this was a clinical notes audit on discharge information, it is unknown whether these people were offered the opportunity to be assessed but declined, or were never offered the opportunity.

The average length of time between injury and surgery of 20 months is earlier in NZ compared with other countries such as Spain (34 months),¹⁴ France (46.1 months)¹⁵ and within the United States (34–50 months depending on the centre).^{16–18}

There are a number of plausible explanations for these observed differences between NZ and other countries. NZ is a small country with two spinal units and a national accident insurance scheme that makes it easier to provide lifetime follow-up after SCI. This 'contained' and specialized service may also help explain why barriers to surgery noted in other studies (such as lack of exposure of physiatrists to this specialized technique, thus limiting referrals to surgeons; inadequate referral network between physiatrists and surgeons; and lack of ability for the surgeons' practice to care for these patients⁶), may be less of an issue in NZ. It could be hypothesized that the existing relationship between the spinal physicians and upper limb surgeons, as well as surgery and post-operative care being provided in a specialized spinal unit may be a major facilitator for the high uptake of surgery in NZ. In addition, the presence of patients undergoing upper limb surgery, as in-patients in BSU, alongside newly injured patients in the same unit not only informs and educates patients but also rehabilitation staff, family members and the wider SCI community of possible surgical options and outcomes. Moreover, the full public funding for the surgical procedures, the increased attendant care, while

Table 4 Surgery versus no-surgery groups

	n	Demographic	Surgery	No surgery	χ^2 -Value	Odds ratio	95% confidence interval		P-value
							Lower	Upper	
Employment status	53	Employed	20	10	2.14	0.38	0.10	1.42	0.143
		Not employed	19	4					
Gender	59	Female	3	11	3.19	3.83	0.94	15.61	0.051
		Male	23	22					
Marital status	58	Partner	13	10	2.92	2.20	0.75	6.43	0.233
		No partner	13	22					
Ethnicity	51	NZ European	19	19	2.86	3.33	0.97	14.05	0.091
		NZ Maori	3	10					

Abbreviation: NZ, New Zealand.

immobilized in plaster and re-hospitalization for rehabilitation may contribute to the higher utilization rates in NZ.

The NZ Maori are overrepresented in NZ SCI statistics, accounting for 21% of injuries despite only constituting 15% of the general population of NZ,⁹ with a higher prevalence of SCI in Maori men in the 15–35 and 45–65 years age groups compared with NZ Europeans in the same age brackets.⁸ Although this study did not show any statistically significant difference between the surgery and no-surgery groups by ethnicity within the NZ population, there seemed to be an underrepresentation of NZ Maori in the surgery group. The reasons for the difference are not known. With regard to ethnicity, significant disparities in health between NZ Europeans and NZ Maori are well documented.¹⁹ Some explanations of the disparities include reduced access to tertiary services, lower referrals for investigations and a poor rapport with General Practitioners.

Women constitute approximately one-third of the SCI population in NZ, yet only comprise 10% of those people choosing to undergo upper limb surgery. It is well documented in many areas of surgery (for instance, cardiac, orthopaedic and transplant surgery) that women tend to present with more severe disease and receive less aggressive care than do men.²⁰ This has also been shown in rheumatoid hand surgery with men more likely than women to receive an early, prophylactic hand procedure; women were more concerned with the recovery time, post-operative pain and risks of surgery or post-operative complications than their male counterparts.²¹ Gender differences in the uptake of surgical procedures has been suggested by Katz *et al.*²⁰ to reflect the greater value men place on their physical function than women, and therefore their willingness to accept the greater potential risk to improve their functional status. They also suggest that practical considerations such as life roles and the need for increased care while rehabilitating may prompt women to defer surgery for as long as possible. Research would be required to determine whether these reasons, or others, influence the decisions of women with SCI regarding upper limb surgery.

As a clinical case series does not fully explore the reasons why people with tetraplegia chose to undergo reconstructive upper limb surgery or not, in phase 2 of this project, the authors plan to explore the process from the perspective of the individual with SCI using a qualitative approach.

The most obvious limitation to this study is the small number of cases limiting the statistical power. Another is the unknown accuracy of discharge lists with regard to injury level. With these lists, there is a possibility of data entry errors, missing or incorrect information. In addition, the study was retrospective, based on clinical notes, computerized Patient Management System and BSU hand surgery file. Although study data collection and data entry were rigorous, the accuracy of data recorded in clinical notes or hand surgery file, or originally entered into the Patient Management System, is uncertain. For example, some information was not recorded at all, particularly employment status at time of injury (six people) and marital status (two people). In such a small sample size, missing data such as this can have a large impact on the analysis.

Conclusion

Utilization of upper limb surgery in the eligible tetraplegic population in NZ was proportionately high. The trends in demographics of ethnicity and gender with regard to surgical status warrant further investigation.

Conflict of interest

This research was supported by a Health Research Council of New Zealand Disability Placement Scholarship for the principal researcher. The remaining authors declare no conflict of interest.

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