Anaesth Intensive Care 2004; **32:** 256-259

Audit

Muscle Weakness After Muscle Relaxants: An Audit of Clinical Practice

W. ALKHAZRAJY*, A. D. KHORASANEE†, W. J. RUSSELL‡

Departments of Anaesthesia and Intensive Care, Royal Adelaide Hospital and University of Adelaide, Adelaide, South Australia

SUMMARY

Residual muscle weakness after general anaesthesia, assessed using handgrip strength, was audited in a teaching hospital. The relationships between residual weakness, the use of muscle relaxants and patient characteristics were examined.

Handgrip strength was measured preoperatively, one hour postoperatively and one day postoperatively using a hand dynamometer in 151 patients having general anaesthesia. Forty-nine patients received no muscle relaxant, 34 patients received vecuronium and 68 received rocuronium. Patients were managed by their anaesthetist according to that anaesthetist's clinical choice. All patients who received muscle relaxants received neostigmine.

One hour postoperatively, there was a decline in handgrip strength of 16% for the no relaxant group, 24% for vecuronium and 29% for rocuronium. The degree of weakness for the relaxant groups was unrelated to age (P=0.89) but was strongly influenced by the patient's sex. Almost all of the increased weakness with relaxants was found in the female patients. The mean decline in handgrip strength in the male patients who received either vecuronium or rocuronium was similar to that seen when relaxants had not been used (P=0.40). One hour postoperatively, female patients showed a marked decrease in handgrip strength after both vecuronium and rocuronium (32% and 34% respectively, combined P=0.01).

These results suggest that in usual clinical practice at our institution, female patients are more likely to have residual weakness after muscle relaxants.

Key Words: NEUROMUSCULAR BLOCKING AGENTS: vecuronium, rocuronium: male, female: dynamometry, handgrip force

Residual weakness after the use of muscle relaxants in association with general anaesthesia has been shown to be quite common[1,2]. Residual muscle weakness after pancuronium has been demonstrated one hour postoperatively. There is little information about the impact of vecuronium and rocuronium on muscle power of patients in the postoperative period.

*M.B., Ch.B., Anaesthetic Registrar, Department of Anaesthesia and Intensive Care, Royal Adelaide Hospital.

†B.App.Sc., B.H.Sc., Research Assistant, University of Adelaide.

‡F.A.N.Z.C.A., F.R.C.A., Ph.D., D.I.C., Director Research and Development, Clinical Professor, Department of Anaesthesia and Intensive Care, Royal Adelaide Hospital and University of Adelaide.

Address for reprints: Dr W. J. Russell, Department of Anaesthesia and Intensive Care, Royal Adelaide Hospital, North Terrace, Adelaide, S.A. 5000.

Accepted for publication on November 12, 2003.

MATERIALS AND METHODS

The audit was conducted after obtaining the approval of the Royal Adelaide Hospital Ethics Committee. We examined muscle weakness (the difference between handgrip strength preoperatively and postoperatively) in the patients audited. All patients had general anaesthesia, and the results were grouped based on whether the patient received no muscle relaxant, rocuronium or vecuronium.

One hundred and seventy-eight patients who attended as elective day-of-surgery admissions (planned for overnight hospital stay) were audited. They all gave verbal consent to participate in the audit after being given an explanatory sheet.

Exclusion criteria were: not having general anaesthesia; not understanding English; not being able to follow instructions; having impaired handgrip preoperatively (e.g. due to diseases such as rheumatoid arthritis); and having surgery which might impair

postoperative handgrip strength (e.g. breast or upper limb surgery). Only those patients who received either no relaxant or either vecuronium or rocuronium were analysed as these three groups represented over 95% of the patients studied. All patients who received a relaxant also received reversal with neostigmine. There was no communication with the anaesthetist about what anaesthetic drugs or muscle relaxants were to be given and no information on patient results were passed back to the anaesthetist.

The assessment of muscle weakness was done using the My-Gripper™ (Japan) dynamometer which has been shown to be a sensitive measure of residual muscle weakness[1]. Handgrip force was assessed preoperatively in the day-of-surgery admission lounge, one hour postoperatively in the postoperative recovery ward and 24 hours postoperatively when the patient was in the surgical ward. The handgrip force at each stage was measured as the mean of three maximum squeezes of the "My-Gripper" dynamometer with the dominant hand.

Statistical analysis was performed using a t-test (paired or unpaired), or ANOVA with two sides.

RESULTS

A total of 178 patients were audited. Twenty-two patients were excluded because they did not complete the three assessments. Five patients who received general anaesthesia with other relaxants were also excluded from analysis. This analysis has been performed on the remaining 151 patients. Forty-nine patients did not receive relaxant, 34 patients received vecuronium and 68 patients received rocuronium.

Ninety-one patients had their ASA status recorded. There was no significant difference in distribution of ASA status between the groups (P=0.159).

At the one hour postoperative assessment, patients who received general anaesthesia without relaxant had a mean diminution of handgrip strength of 16.1%. Patients who received vecuronium had a mean diminution of handgrip strength of 23.9% and those who received rocuronium had a mean reduction of 29.3%. There was no significant trend to a greater or lesser weakness with increasing age (Figure 1). This was true for both males (r=0.11, P=0.51) and females (r=0.02, P=0.86).

There was a striking difference in decline in hand-

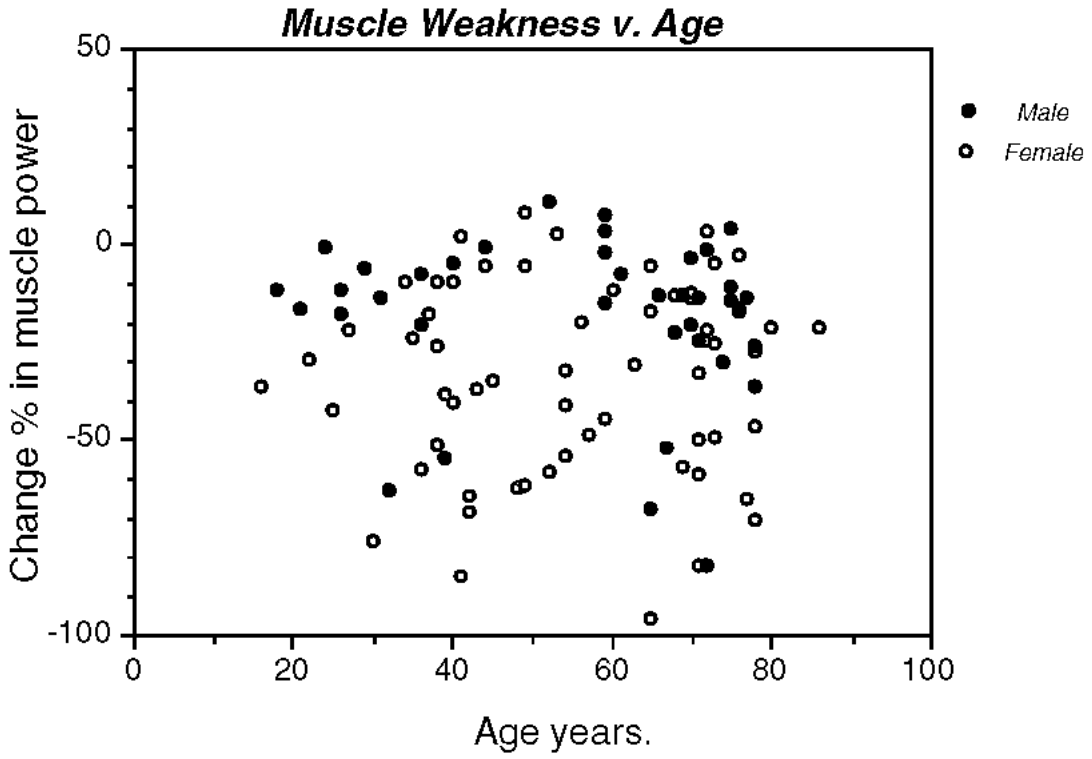

FIGURE 1: Plot of age against the decrease in muscle power with relaxants for each patient. Overall there is no trend with age. The male patients are designated by a solid dot and the female patients are designated by an open dot. It can be seen that there is a tendency for females to have a greater decrease in muscle power, but this is not related to age for either group.

grip strength in relation to muscle relaxant exposure between the sexes (Table 1). The mean (SD) decline in handgrip strength of the male and female patients who did not receive relaxant was similar (–13.87± 14.49 and –18.59±18.70 respectively, $P=0.33$). Female patients who received muscle relaxants had a greater decline in handgrip strength with both vecuronium ($P=0.04$) and rocuronium ($P=0.01$) than female patients who received no relaxant. In contrast, male patients who had relaxants had no greater decline in handgrip strength than those who did not have relaxants ($P=0.52$, ANOVA).

TABLE 1
Percentage change in handgrip at one hour

Relaxant	Male			Female		
	Mean	Standard Deviation	Number	Mean	Standard Deviation	Number
None	–13.87	14.49	26	–18.59	18.71	23
Vecuronium	–14.73	19.55	17	–32.73	23.32	17
Rocuronium	–19.60	21.37	23	–34.19	25.16	45

Handgrip strength had largely recovered in all groups by the 24 hour measurement. Clinically insignificant decreases in handgrip strength at the twenty-four hour measurement compared to the pre-operative measurement were noted in all groups. These differences were not statistically significant in those who received no muscle relaxant ($P=0.746$), nor in men who had received muscle relaxants ($P= 0.582$) but statistically significant ($P=0.0002$) in women who had received muscle relaxants.

Male and female patients who received relaxant had similar absolute doses. For vecuronium, males received a mean dose of 9.18 mg (SD 3.09, N=15) which was similar to the dose given to females, mean 8.46 mg (SD 3.45, N=16), $P=0.55$. For rocuronium, males received a mean dose of 53.6 mg (SD 19.3, N=18) which was similar to the dose given to females, mean 50.2 mg (SD 11.0, N=41), $P=0.39$. In addition, the duration of anaesthesia was similar for both sexes. With vecuronium, males had a mean duration of anaesthesia of 110 minutes (SD 47.9, n=15) and females a mean duration of 120 minutes (SD 36.4, n=16) $P=0.52$. For rocuronium, males had a mean duration of anaesthesia of 85.8 minutes (SD 43.4, n=18) and females a mean duration of 86.8 minutes (SD 36.0, n=41) $P=0.93$. Thus, although the audit did not control the dose of relaxant or the duration of anaesthesia, these appeared to be similar in both the male and the female groups for each relaxant.

DISCUSSION

Postoperative muscle weakness can be a cause of serious morbidity and the development of complications during the postoperative period. In some patients, such as those with inadequate respiratory reserve, full recovery of respiratory muscle strength is essential. Whether the degree of weakness found here is of clinical importance in most patients is unclear.

In this audit, general anaesthesia alone resulted in a slight flexor forearm muscle weakness postoperatively. The use of vecuronium or rocuronium resulted in significantly greater muscle weakness in female patients one hour postoperatively compared with females who had not received relaxants. Male patients who received muscle relaxants had a decline in handgrip strength similar to males who did not receive relaxants. The explanation for these observations is unclear. Female patients received similar doses of relaxant compared to males, but, given the likely smaller lean body mass in females, this could represent a relative overdose of relaxant.

The significant declines in handgrip strength noted at one hour postoperatively had largely recovered in all groups at the 24 hour measurement compared with the preoperative measurement. There was a statistically significant weakness still present at 24 hours in female patients who had received relaxants but the small absolute value of this decline compared to preoperative measurements seemed likely to be clinically insignificant.

Sex differences for some drug effects are well recognised, such as the female susceptibility to post-operative nausea and vomiting being two to three times greater than in males[3] and a tendency for females to have more rapid awakening from general anaesthesia[4]. With relaxants, work by Xue and co-workers has suggested a sex difference in the effect of muscle relaxants[5]. They found that females were approximately 30% more sensitive than males to rocuronium by train-of-four testing during anaesthesia. They also found that the neuromuscular block was significantly longer in males than females so that possibly the two effects, susceptibility and duration of action may nullify each other giving a similar post-operative recovery. They did recommend a reduced dose of relaxant in females. Semple and coworkers also compared male and female sensitivity to vecuronium by train-of-four electromyography during anaesthesia[6]. They found females more sensitive, requiring 22% less drug on a per kilogram basis to achieve the same degree of block. We are not aware of any previous work looking at muscle power during recovery that has identified a sex difference. Bailland et al investigated residual block after vecuronium

without reversal in 568 patients. They found that older patients were more susceptible but did not find any differences between the sexes[7].

The major finding in this audit is that female patients who have received a muscle relaxant in conjunction with a general anaesthetic have a substantially greater risk of muscle weakness one hour after the procedure. Thus extra care is appropriate with female patients requiring muscle relaxants with general anaesthesia. From these data, there is a case for minimizing the dose of relaxant in females, perhaps by titration with neuromuscular monitoring, to reduce their greater risk of postoperative weakness. Certainly close monitoring of muscle power is warranted during recovery in female patients who have been given relaxant anaesthesia.

ACKNOWLEDGEMENTS

We would like to thank the staff of day-of-admission and general theatre recovery wards of the Royal Adelaide Hospital for their co-operation in the conduct of this study.

REFERENCES

1. O'Connor M, Russell WJ. Muscle strength following anaesthesia with atracurium and pancuronium. Anaesth Intensive Care 1986; 16: 255-259.
2. Russell WJ, Serle DG. Handgrip force as an assessment of recovery from neuromuscular block. J Clin Monitor 1987; 3:87-89.
3. Lerman J. Surgical and patient factors involved in postoperative nausea and vomiting. Br J Anaesth 1992; 69, Suppl 1:24S-32S.
4. Gan TJ, Glass PS, Sigl J et al. Women emerge from general anesthesia with propofol/alfentanil/nitrous oxide faster than men. Anesthesiology 1999; 90:1283-1287.
5. Xue FS, Tong Sy, Liao X, Lui JH, An G, Luo LK. Dose-response and time course of effect of rocuronium in male and female anesthetized patients. Anesth Analg 1997; 85:667-671.
6. Semple P, Hope DA, Clyburn P, Rodbert A. Relative potency of vecuronium in male and female patients in Britain and Australia. Br J Anaesth 1994; 72:190-194.
7. Baillard C, Gehan G, Reboul-Marty J, Larmignat P, Samama CM, Cupa M. Residual curarization in the recovery room after vecuronium. Br J Anaesth 2000; 84:394-395.