

Original article

Multimodal (fast-track) rehabilitation in elective colorectal surgery: Evaluation of the learning curve with 300 patients[☆]

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Introduction: The aim of this paper is to assess the learning curve on compliance to the application of a multimodal rehabilitation program (MMRP) protocol and patient recovery after elective colorectal surgery.

Material and methods: A comparative prospective study of 3 consecutive cohorts of 100 patients (P1, P2 and P3) who had colonic or rectal surgery. The same MMRP protocol was applied in all cases. Compliance to the protocol, tolerance to the diet and walking have been analysed. The percentages of early hospital discharges have also been compared.

Results: Compliance gradually improved, reaching statistical significance between P1 and P3. Starting the diet on day 1 post-surgery was 52% vs 86% ($P=.0001$) and the removal of drips was 21% vs 40% ($P=.005$). This difference remained during days 2 and 3. Tolerance to the diet on day 1 (P1: 34% vs P3: 66%; $P=.0001$) and walking on day 2 (P1: 41% vs P3: 68%; $P=.0002$) were also better in the third period. No differences in morbidity were found between the three periods. The percentage of hospital discharges on day 3 P1: 1% vs P3: 15%; $P=.0003$, day 4 (P1: 12% vs P3: 32%; $P=.001$) and day 5 (P1: 30% vs P3: 50%; $P=.002$) was higher in the third period.

Conclusions: The compliance to the protocol and the results of applying the MMRP improved significantly with the greater experience of the professionals involved.

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Rehabilitación multimodal en cirugía electiva colorrectal: evaluación de la curva de aprendizaje con 300 pacientes

R E S U M E N

Palabras clave:

Rehabilitación multimodal

Fast-track

Cirugía colorrectal

Introducción: El objetivo es evaluar la influencia del aprendizaje en la aplicación de un programa de rehabilitación multimodal (RHMM) sobre el cumplimiento del protocolo y la recuperación de los pacientes intervenidos de cirugía electiva colorrectal.

Material y métodos: Estudio prospectivo comparativo de 3 cohortes consecutivas de 100 pacientes (P1, P2 y P3) intervenidos de cirugía de colon o recto. En todos los casos se aplicó

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el mismo protocolo de RHMM. Se ha analizado el cumplimiento del protocolo, tolerancia a la dieta y deambulaci3n. Tambi3n se han comparado los porcentajes de alta hospitalaria precoz.

Resultados: El cumplimiento mejor3 progresivamente alcanzando la significaci3n estadística entre P1 y P3: el inicio de la dieta el día 1 del postoperatorio fue de 52 vs. 86% ($p = 0,0001$) y la retirada de sueros fue de 21 vs. 40% ($p = 0,005$). Esta diferencia se mantuvo durante los días 2 y 3. La tolerancia a la dieta en el día 1 (P1: 34 vs. P3: 66%; $p = 0,0001$) y la deambulaci3n en el día 2 (P1: 41 vs. P3: 68%; $p = 0,0002$) tambi3n fueron mayores en el tercer periodo. No encontramos diferencias en la morbilidad entre los 3 periodos. El porcentaje de altas hospitalarias en el día 3 (P1: 1 vs. P3: 15%; $p = 0,0003$), día 4 (P1: 12 vs. P3: 32%; $p = 0,001$) y día 5 (P1: 30 vs. P3: 50%; $p = 0,002$) fue mayor en el tercer periodo.

Conclusiones: El cumplimiento del protocolo y los resultados de la aplicaci3n de un programa de RHMM mejoran significativamente con la mayor experiencia de los profesionales implicados.

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Introduction

During the last decade we have witnessed a slow but progressive increase in the use of multimodal rehabilitation programs, also called "fast track", proposed by Kehlet.^{1,2} These programs are based on combining various initiatives to reduce surgical stress and facilitate the patient's postoperative recovery. Its implementation requires the coordination of various specialists involved in different phases. Multimodal rehabilitation programs are characterised by giving complete oral and written information to patients, emphasizing the importance of their active involvement in the process, the implementation of an optimal analgesic protocol, the restriction of fluid overload, stimulation of early mobility and early initiation of diet. Thus, multimodal rehabilitation programs have managed to not only accelerate postoperative patients' evolution, but also reduce complications, thus shortening hospital stay.

Our hospital launched a multimodal rehabilitation protocol in elective colorectal surgery in March 2006 based on the *Enhanced Recovery After Surgery* (ERAS)³ project. Initial analysis of its application demonstrated its safety, as no increased morbidity or mortality was found compared with a control group, and it resulted in a reduction in hospital stay of three days.⁴

Some authors have suggested that the level of experience of the work team influences the results when implementing a multimodal rehabilitation program. Therefore, surgeons with more experience in the implementation of the protocol achieve shorter hospital stays than those surgeons without experience in its application.⁵ The aim of this study is to evaluate the influence of apprenticeship in a multimodal rehabilitation program on compliance with the protocol and its impact on functional recovery of patients who undergo elective colorectal surgery in our centre.

Material and methods

Study design

Prospective comparative study comparing 3 consecutive cohorts.

Study population

We studied 300 patients undergoing colorectal surgery from March 2006 to February 2008. All patients were operated by the same group of surgeons from the Colorectal Surgery Unit of Hospital del Mar. A comparative analysis was conducted of three consecutive groups of 100 patients each. The P1 group (000-100) consists of the first 100 (operated from 22/03/06-18/01/07), the P2 group (101-200) consisting of the next 100 (from 19/01/06-19/07/07), and finally the P3 group (201-300) with the last 100 patients (from 07/20/07 to 02/22/08). The only inclusion criterion was elective surgery of the colon or rectum. No exclusion criteria were established.

Multimodal rehabilitation protocol

All patients underwent the multimodal rehabilitation protocol previously described by our group.³ The highlights are:

- Preoperative phase: oral and written information given by the treating surgeon and nurses in outpatient settings. Patients were admitted the day before surgery to start the colon preparation with polyethylene glycol while administering a carbohydrate solution (135 g of carbohydrate in 1000 cc) in the form of enteral nutrition (Edanec®) and oral hydration up to 6h before surgery.
- Perioperative phase: Use of short-acting anaesthetics. Adjusted hydration with replacement of blood loss and insensitised loss adjusted to 6-8 ml/kg/h. Administration of fluid therapy and use of a temperature-controlled thermal blanket.

- Postoperative phase: Postoperative analgesia with epidural catheter for 48 hours. Progressive diet after 4-6 h post-operation. Withdrawal of fluid therapy when the patient tolerates the liquid diet. Encouragement of early mobility.

Definition of criteria for hospital discharge: tolerance of a solid diet, pain controlled with oral analgesia and proper mobilisation of the patient.

Variables analysed

We compared demographic and clinical characteristics of the patients in each group as well as surgical procedures. We analysed the performance of the protocol, highlighting the start of the diet and fluid withdrawal by the nursing staff and/or physician. Tolerance of the diet and mobility were measured as parameters of functional recovery. Medical and surgical complications were recorded, as well as mortality during the first 30 postoperative days in the 3 groups. We also compared the average hospital stay and readmission rate between the three groups. Lastly, we analysed the progression of discharges in each group.

Statistical analysis

We performed descriptive statistics and comparisons of variables. Qualitative variables are expressed in absolute numbers or proportions and quantitative variables by mean and standard deviation. The test of hypothesis testing was the chi-squared test and Fisher's exact test for ordinal qualitative variables (comparison of proportions) and the Student's t test for continuous variables if applicability criteria were met. A value of $P < .05$ was considered statistically significant.

Results

Table 1 shows the demographic characteristics of patients, including sex, age and surgical risk associated with underlying

disease according to American Society of Anesthesiologists (ASA) classification as well as clinical characteristics including type of surgery and the percentage of laparoscopic surgery without significant differences in any of these variables.

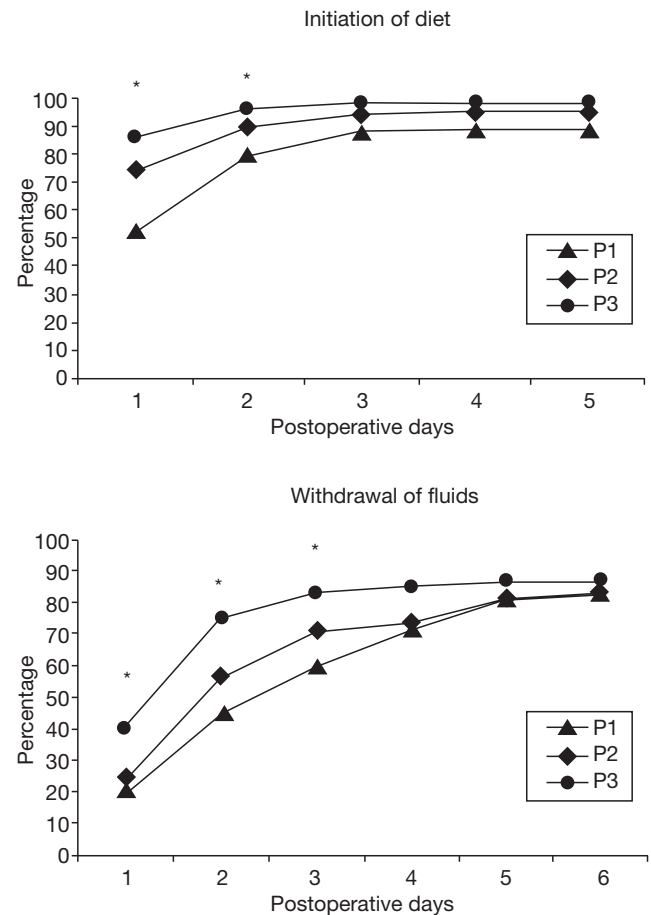


Figure 1 – Protocol compliance analysis, assessing initiation of the diet and withdrawal of fluid therapy in patients in the three groups. * $P < .005$ between group P1 and group P3

Table 1 – Demographic and clinical variables of the patients in the 3 groups

	P1 n=100	P2 n=100	P3 n=100	P ^c value
Sex, male/female	57/43	63/37	66/34	.2
Age, years ^a	66±15	65±15	70±11	.07 ^b
ASA 1/2/3/4	5/60/33/2	2/72/25/1	2/61/35/2	0.9
Right hemicolectomy	19	19	24	.5
Left hemicolectomy	26	23	24	.9
Anterior resection	16	29	18	.9
Miles' resection	8	3	2	.1
Stoma closure	16	18	21	.5
Benign/malignant	20/80	24/76	22/78	.8
Laparoscopic surgery	12	11	23	.06
Surgical duration	172±85	165±81	152±75	.08

Values are absolute numbers and percentages given the n in each group is 100, unless otherwise indicated.

ASA indicates American Society of Anesthesiologists

^aMean±standard deviation.

^bStudent's t test.

^cChi-squared test unless otherwise indicated.

The protocol compliance analysis is shown in Figure 1. We can see a progressive increase in the percentage of patients who start the diet and those for whom fluid therapy was withdrawn in the first postoperative day. Although we

found no differences between the three groups, we did see significant differences when comparing the P3 group with the P1 group. On postoperative day 1 52% of patients in the P1 group started their diet compared with 86% of patients in the P3 group ($P=.0001$). This difference also remains in the second postoperative day (P1:79% vs P3:96%, $P=.0004$). Fluid withdrawal on day 1 occurred in 21% of group P1 patients, reaching 40% of patients in the P3 group ($P=.005$). This difference remained significant on day 2 (P1:45% vs P3: 75%, $P=.0001$) and day 3 (P1:60% vs P3: 83%, $P=.0006$) after surgery, as is shown in Figure 1.

Tolerance to diet and mobility reflect functional recovery of the patient (Figure 2). When analysing tolerance to the liquid diet on day 1 after surgery, again we observe statistically significant differences between the first and third groups (P1: 34% vs P3: 66%, $P=.0001$). On the other hand, patient mobility showed differences between the P1 and P3 groups both on day 2 after surgery (P1: 41% vs P3: 68%, $P=.0002$) and day 3 (P1: 67% vs P3: 88%, $P=.0006$).

Table 2 shows the overall morbidity in each of the three groups, without finding significant differences between them. The morbidity rate also includes that corresponding to readmissions. We did not find significant differences between the three groups when broken down by medical and surgical complications. Among the surgical complications, surgical site infections showed no significant variations between groups. Mortality was also similar among the three study groups.

Table 3 shows the average hospital stay in the 3 groups. We can observe a decrease of 1 day in the fourth quarter compared with the first 2 but it does not reach statistical significance. We also observed a decrease in the percentage of readmissions and found no significant differences. On analysing the total stay, including the initial hospital stay plus the readmission stay, no statistically significant differences were found.

Figure 3 shows the progression of discharges in the three study periods. The comparative analysis of the percentage of discharged patients showed significant differences between groups P1 and P3 on day 3 (P1: 1% vs P3: 15%, $P=.0003$) on day

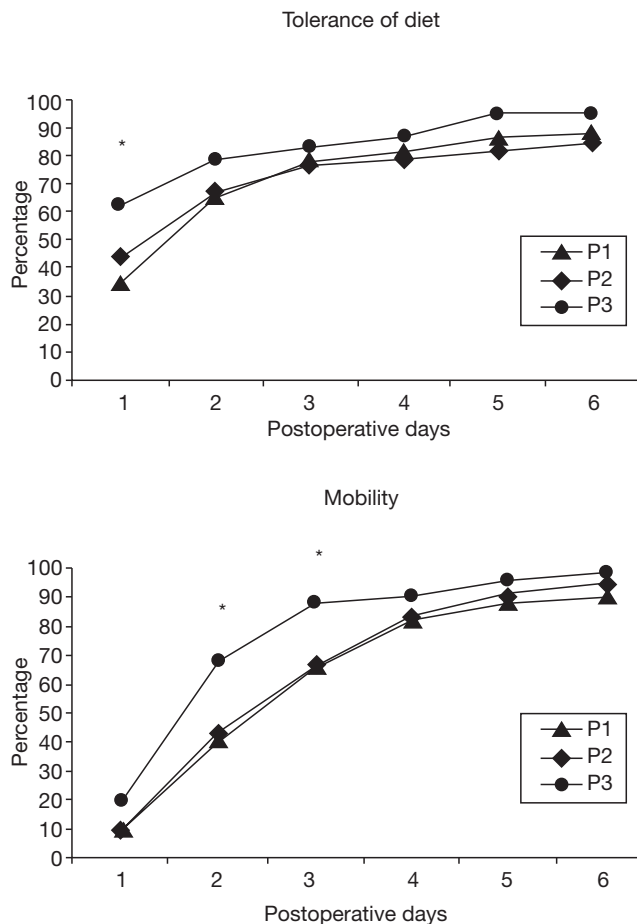


Figure 2 – Analysis of functional recovery of patients in each of the three groups, assessing tolerance to diet and mobility.
* $P<.001$ between group P1 and group P3.

Table 2 – Morbidity and mortality compared among the 3 groups

	P1 n=100	P2 n=100	P3 n=100	P ^c value
Global morbidity	38	40	35	.8
Medical complications	16	11	8	.2
Surgical complications	26	32	33	.4
Infection of surgical site	13	16	16	.7
Infection of surgical incision	9	10	10	1 ^a
Organ-space infection	4	6	6	.7 ^a
Intra-abdominal abscess	2	4	3	1 ^a
Anastomotic dehiscence ^b	2.2	2.2	2.2	1 ^a
Mortality	1	1	0	1

Values are absolute numbers and percentages given the n in each group is 100, unless otherwise indicated.

^aFisher's exact test.

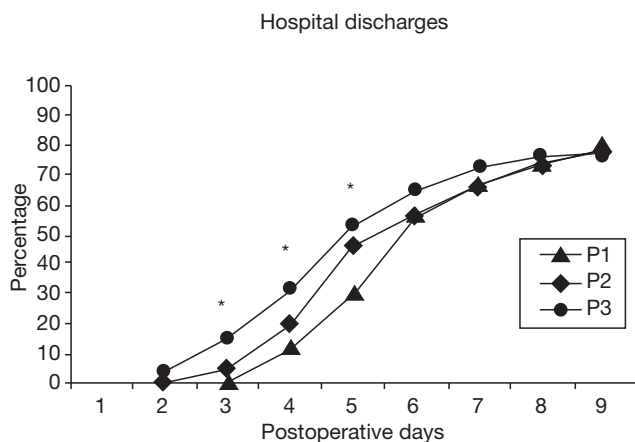
^bPercentage of anastomotic dehiscence calculated in relation to the number of stitches: 90 in the P1 group, 91 in the P2 group, and 92 in the P3 group.

^cChi-squared test unless otherwise indicated.

Table 3 – Hospital stay and readmissions in the 3 groups

	P1 n=100	P2 n=100	P3 n=100	P value
Preoperative stay ^a	1.1±0.4	1.1±0.4	1±0.4	.07 ^b
Hospital stay, days ^a	8.6±7	8.7±8	7.7±6	.3 ^b
Readmissions, %	11	9	8	.6 ^c
Total stay, days ^a	9.7±7	9.8±8	8.4±8	.2 ^b

^aMean±standard deviation.
^bStudent's t test.
^cChi-squared test/Fisher's exact test.

**Figure 2 – Analysis of the increase in the number of hospital discharges according to the postoperative day in each group.*** $P < .05$ between group P1 and group P3.

4 (P1: 12% vs P3: 32%, $P = .001$) and on day 5 (P1: 30% vs P3: 50%, $P = .002$) immediately post-operation.

When analysing the entire series of 300 patients, we found differences in the outcome of the multimodal rehabilitation protocol depending on the type of surgical procedure (colon surgery vs rectal) and also on the approach. Therefore, tolerance to the liquid diet on day 1 was 47% in those with segmental resection of the colon compared to 25% in those with resection of the rectum ($P = .008$) and hospital stay was 7.8 ± 7.3 days for those with resection of colon versus 10.8 ± 6.9 days for those with surgery for rectal cancer ($P = .005$). Similarly, we also observed differences in some of the variables of functional recovery between open and laparoscopic surgery. The rate of early discharge on day 4 after surgery was 49% in patients who underwent laparoscopic surgery compared to 12% in those patients undergoing open surgery ($P < .001$). These differences remained over the three periods of study and were not affected by the learning curve.

Discussion

Multimodal rehabilitation programmes in abdominal surgery have succeeded in improving postoperative progress,

resulting in shorter hospital stays while at the same time ensuring patient safety and does not increase the morbidity and mortality.^{6,7} Some groups have shown a decrease in the percentage of complications.^{8,9}

The multidisciplinary nature of these protocols, together with the need to change professional habits acquired over the years, poses a greater difficulty in implementation.¹⁰ Some authors have suggested that compliance improves with experience.⁵ Along these lines, the results of this study demonstrate what could be called a learning curve in setting up and subsequent implementation of a multimodal rehabilitation protocol. We saw a gradual improvement in protocol compliance, particularly in diet initiation and withdrawal of fluid therapy and functional recovery of patients, as evaluated in our study by dietary tolerance and mobility. Functional recovery of patients is parallel to the improvement in compliance with the protocol.

It is noteworthy that following the introduction of the rehabilitation protocol we observed low initial compliance and that only half of patients in the P1 group started their diet on day 1 after surgery. This figure clearly shows the difficulty of changing the traditional protocols of preoperative care. Once their use is consolidated in the third period, this percentage increased to almost 90%. Although previous publications of groups with more experience in multimodal rehabilitation mentioned the difficulty in initial implementation of these protocols, despite the evidence available,¹¹ we did not find this information quantified previously. The same applies to other measures of the protocol studied, such as withdrawal of fluid therapy or the onset of mobility, which gradually improved over the study period. It is important to note that the team of surgeons who carried out the surgery and who participated in the implementation of the protocol was the same in the three periods, so there were no changes that might have interfered with the learning curve.

In this study, we observed no differences among the three groups in terms of medical or surgical complications. The results of postoperative morbidity as related to the implementation of multimodal rehabilitation protocols in the literature are highly variable. A systematic review by Wind et al found incidences of disease ranging from 8%-75%.² On this subject, a correct definition of complications is important, as well the use of classification systems, which are a controversial issue.¹² Although there are specific classification proposals,¹³

they are based primarily on the treatment required by the complication, so there continues to be a lack of consensus on the definition of complications. It should be noted that in our initial work, we found no differences in the incidence of postoperative complications in comparison with a control group before the introduction of RHMM programme.⁴ Since the introduction of the protocol, our priority has been safety, i.e., having no complications related to implementation of the protocol by the various specialists involved.

Delaney et al observed that when surgeons experienced with such programmes implemented the rehabilitation protocol, hospital stay was significantly lower than when applied by surgeons who had no previous experience with it.⁵ In this study, we observed a decrease in the average hospital stay of 1 day in the P3 group, but it did not reach statistical significance. This may be explained by the absence of differences in postoperative morbidity. The rate of serious complications that significantly prolong the stay is similar between the three groups, so the impact of learning on the implementation of the protocol on the average stay is more limited than it is on other indicators, as we have seen. We believe that patients without complications see a greater benefit from a multimodal rehabilitation protocol. Therefore, this study shows that greater experience in the use of the protocol is reflected in an increase in early hospital discharges in the first 5 post-operative days. In a recent study, Delaney et al observed that patients who were discharged between 24-72 h had fewer postoperative complications and fewer readmissions than those who had been discharged beyond the 72 hours, although the differences did not reach statistical significance. Clearly, they do not have fewer complications because they are discharged earlier. It is the fact that they meet discharge criteria at an early stage that indicates they have a low risk of complications.¹⁴

Hospital readmissions also declined during the learning period, but did not reach statistical significance. Although with the implementation of multimodal rehabilitation protocols readmission rates of up to 20%⁸ have been reported, our results are within the range reported in most publications.²

The implementation of a multimodal rehabilitation protocol is continuously evolving and is an active process of constant change to improve the postoperative patient progress.¹⁵ The recommendations proposed by Kehlet in the consensus on the ERAS³ protocol are validated in the literature with varying degrees of evidence,¹¹ not all of which are included in our protocol. Regarding mechanical bowel preparation there is evidence that it does not improve outcomes and may increase patient dehydration in addition to the hassle of its ingestion.¹⁶ In the initial stages of our protocol we still performed colon preparation, but since January 2008 only in patients who had to be operated for rectal neoplasm. The damage due to perioperative fluid overload is widely documented.¹⁷⁻¹⁹ In the initial results we achieved a 40% reduction in fluid therapy during surgery.⁴ The use of the esophageal Doppler for optimisation of fluid therapy as a function of cardiac load has been recommended, but it has only proven useful in high-risk surgical patients.²⁰ The reduction in hours of fasting and administration of a carbohydrate solution appear to decrease the surgical stress response.^{21,22} In designing

our protocol we reduced this period from 8 hours to 6 hours. Currently the scientific evidence supports the reduction of fasting to 6 h for solids and 2 hours for liquids.²⁰ Access by laparoscopy,^{23,24} or transverse incisions instead of vertical,²⁵ not administering preoperative intrabdominal tranquilizers,²⁶ not leaving interabdominal drains²⁷ and the systematic use of laxatives and antiemetics to decrease ileus, are all measures recommended in multimodal rehabilitation protocols.

Despite the obvious benefit of these protocols, implementation has been slow as seen in the literature²⁸ and there are several reasons. It is difficult to change traditional patterns acquired during years of medical practice, especially if these habits had good results.²⁹ Nevertheless, evidence-based medicine proposes changes to these practices to achieve an improvement in the final results. This fact should encourage any surgical unit to change their own habits, accepting that the process will imply a learning curve with improvement over time. In conclusion, the results of our study show that compliance and the results of the implementation of a multimodal rehabilitation protocol improve significantly with the greater experience of the professionals in their implementation.

Conflict of interest

The authors affirm that they have no conflicts of interest.

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