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Umbilical Herniorrhapy in Cirrhosis: Improved Outcomes with Elective Repair

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Abstract
Objective This study was undertaken to examine the effect of cirrhosis on elective and emergent umbilical herniorrhapy outcomes.
Methods Procedures were identified from the Veterans' Affairs National Surgical Quality Improvement Program at 16 hospitals. Medical records and operative reports were physician abstracted to obtain preoperative and intraoperative variables.
Results Of the 1,421 cases reviewed, 127 (8.9%) had cirrhosis. Cirrhotics were more likely to undergo emergent repair (26.0% vs. 4.8%, $p<0.0001$), concomitant bowel resection (8.7% vs. 0.8%, $p<0.0001$), return to operating room (7.9% vs. 2.5%, $p=0.0006$), and increased postoperative length of stay (4.0 vs. 2.0 days, $p=0.01$). Best-fit regression models found cirrhosis was not a significant predictor of postoperative complications. Significant predictors of complications were emergent case (OR 5.4; 95% CI 3.1–9.4), diabetes (OR 2.1; 95% CI 1.2–3.8), congestive heart failure (OR 4.0; 95% CI 1.4–11.4), and chronic obstructive pulmonary disease (OR 2.0; 95% CI 1.1–3.6). Among emergent repairs, cirrhosis (OR 4.4; 95% CI 1.3–14.3) was strongly associated with postoperative complications.
Conclusion Elective repair in cirrhotics is associated with similar outcomes as in patients without cirrhosis. Emergent repair in cirrhotics is associated with worse outcomes. Early elective repair may improve the overall outcomes for patients with cirrhosis.

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Introduction

The prevalence of umbilical hernias in cirrhotic patients with ascites is as high as 20%, with recurrence rates after repair in those patients as high as 60%.[1,2] Obesity, chronic cough, smoking, and ascites are contributing factors to the development of umbilical hernias in adults.[3] The increased intra-abdominal pressure associated with ascites is thought to predispose cirrhotic patients to the development of umbilical hernias.

Cirrhotic patients are considered to be high surgical risk, with increased perioperative morbidity and mortality.[4,5] Among good risk patients, umbilical herniorrhaphy is a relatively straightforward operation with low morbidity and

mortality. Complications of umbilical hernias in cirrhotic patients include leakage, ulceration, rupture, and incarceration.[2] Repair of umbilical hernias in the cirrhotic patients has been associated with elevated morbidity, mortality, and recurrence rates.[6] Surgery in cirrhotic patients is considered by many surgeons to be high risk, and there is a tendency to reserve umbilical hernia repair (UHR) until bowel-related complications develop, such as incarceration, strangulation, rupture, ulceration, and leakage of ascitic fluid.[7] The development of incarceration, strangulation, ulceration, and rupture further elevate the risk of surgical repair. Additionally, surgical repair of incarcerated hernias in cirrhotic patients is associated with an elevated morbidity and mortality rate.[2,7,8]

Prior studies have documented increased morbidity and mortality among cirrhotic patients undergoing emergent surgical procedures.[9,10] The aim of this study is to describe the effect of cirrhosis on short-term UHR outcomes. We examine the effect of preoperative comorbidities obtained from the Veterans' Affairs National Surgical Quality Improvement Program (VA NSQIP) data and surgery specific variables obtained from operative note abstraction. We specifically focus on the effect of emergent or elective case status on UHR outcomes, especially postoperative complications and hospital resource allocation.

Materials and Methods

Study Design

This is a retrospective cohort analysis of subjects undergoing UHR at 16 VA Medical Centers (VAMC) affiliated with surgical residency programs across the USA between 1998 and 2002. Institutional review board approval and waiver of informed consent was obtained at all participating VAMCs. Eligible procedures were identified by querying the VA NSQIP database by Current Procedure Terminology (CPT) codes for ventral hernia repair (49560, 49561, 49565, 49566, 49568, 49570, 49572, 49580, 49585, 49587, 49590, and 49659). Individual operative notes obtained from each site were physician abstracted to identify the type of hernia repair, method of repair, intraoperative enterotomy or bowel resection, and other operative variables. Outcome variables were obtained from the VA NSQIP, the VA National Patient Care Database, and the computerized patient record system (CPRS).

Study Databases

The VA NSQIP prospectively collects data from all 123 VA facilities that perform surgery and includes preoperative, intraoperative, and postoperative outcome variables. The VA NSQIP accrues the CPT code and date of procedure on all non-cardiac cases performed in the VA system. Additional risk variables are collected on a subset of patients based on a sampling algorithm that minimizes bias from high-volume centers and roughly includes 70% of all major operations performed.[11,12] Thirty-day morbidity and mortality data, operative time, and length of stay were obtained from the VA NSQIP database.

The VA National Patient Care Database is comprised of the Patient Treatment File (PTF) and the Outpatient Care Files (OPC).[13] The PTF is a national VA database that includes all admissions to VA hospitals along with up to ten ICD-9 diagnostic and procedure codes. The OPC is a national VA database that contains information on all ambulatory contacts with VA staff.

The CPRS is the comprehensive electronic medical record available through web access. Chart abstraction for patients with cirrhosis identified from the PTF and the OPC was performed to confirm the diagnosis of cirrhosis.

Study Population

Based on VA NSQIP query, we identified all patients at the 16 VA hospitals with CPT codes listed above. Patients were excluded if the repair was not an umbilical hernia repair (i.e., incisional hernia repair or ventral hernia repair), if there was a same site concomitant procedure (i.e., cholecystectomy or planned colectomy), if their operative note was not available for abstraction, or if the case had one or more missing NSQIP preoperative risk variables.

Study Variables

The main variable of interest, cirrhosis, is not included in the VA NSQIP dataset. Cirrhosis was defined by the presence of an associated ICD-9 code in the medical record. The PTF and OPC were queried with ICD-9 codes for chronic liver disease and cirrhosis (571), alcoholic cirrhosis of liver (572.2), cirrhosis of liver without mention of alcohol (571.5), and biliary cirrhosis (571.6). The presence of ascites is a VA NSQIP variable defined as the presence of fluid accumulation within the peritoneal cavity noted on physical examination or abdominal imaging within 30 days before the operation.

Additional variables of interest were patient-level demographics (age and gender), preoperative comorbid conditions, technique of repair, history of prior repair, and intraoperative variables. The presence of any full-thickness bowel-wall injury recorded in the operative note was considered an enterotomy. The occurrence of a bowel resection documented in the operative record that was not planned before operation was included in this analysis. The presence of bowel strangulation or obstruction recorded in the operative note was considered an indication of

compromised bowel. Preoperative risk factors were defined using the VA NSQIP definitions. A dichotomous variable was constructed for technique of repair to classify repairs as either suture or mesh.

The effect of cirrhosis on UHR outcomes was examined. Dichotomous outcomes of interest were the occurrence of one or more postoperative complications or return to operating room within 30 days of the original operation. Continuous

Table 1 Study Demographics, Patient Comorbidities, and Procedure Variables by Presence of Cirrhosis

Variable		Number of Patients	Percent	+ Cirrhosis		− Cirrhosis		Odds Ratio	95% CI	*p* Value
				N	Percent	*N*	Percent			
Overall		1,421		127	8.9	1,294	91.1			
Sex[a]										
Male		1,370	97.7	121	98.4	1,249	97.7	1.5	0.3–6.2	0.6
Female		32	2.3	2	1.6	30	2.4			
Race[b]										
White		976	68.9	98	77.2	878	68.1			0.1
Black		140	9.9	9	7.1	131	10.2			
Other		301	21.2	20	15.8	281	21.8			
Age										
<55		750	52.8	57	55.1	693	46.5	0.7	0.5–1.0	0.06
≥55		671	47.2	70	44.9	601	53.6			
Preoperative risk factors										
Smoke	Y	459	32.3	60	47.2	399	30.8	2.0	1.4–2.9	0.002
	N	962	67.7	67	52.8	895	69.2			
Alcohol abuse	Y	150	10.6	24	18.9	126	9.7	2.2	1.3–4.5	0.001
	N	1,271	89.4	103	81.1	1,158	90.3			
Chronic steroid use	Y	35	2.5	5	3.9	30	2.3	1.7	0.7–4.5	0.3
	N	1,386	97.5	122	96.1	1,264	97.7			
CHF[c]	Y	20	1.4	3	2.4	17	1.3	1.8	0.5–6.3	0.3
	N	1,401	98.6	124	97.6	1277	98.7			
Diabetes	Y	152	10.7	16	12.6	136	10.5	1.2	0.7–2.1	0.5
	N	1,269	89.3	111	87.4	1,158	89.5			
COPD[d]	Y	150	10.6	13	10.2	137	10.6	1.0	0.5–1.8	0.9
	N	1,271	89.4	114	89.8	1,157	89.4			
ASA Class [e]										
1–2		750	52.8	16	12.6	734	56.7	9.1	5.3–15.5	<0.0001
≥3		671	47.2	111	87.4	560	43.3			
Case status[f]										
Elective		1,325	93.3	94	74.0	1231	95.2	7.0	4.3–11.2	<0.0001
Emergent/urgent		95	6.7	33	26.0	62	4.8			
Bowel status[g]										
Compromised bowel	Y	31	2.2	13	10.3	18	1.4	8.1	3.9–17.0	<0.0001
	N	1,385	97.8	113	89.7	1,272	98.6			
Repair history[h]										
Primary		1,302	92.5	112	88.2	1,190	93.0	1.8	1.0–3.2	0.05
Recurrent		105	7.5	15	11.8	90	7.0			
Anesthetic										
General		1,221	85.9	116	91.3	1,105	85.4	1.8	1.0–3.4	0.07
Other		200	14.1	11	8.7	189	14.6			

[a] Sex missing for 19 procedures
[b] Race missing for four procedures
[c] Congestive heart failure
[d] Chronic obstructive pulmonary disease
[e] American Society of Anesthesiologists' Class
[f] Case status missing for one procedures
[g] Bowel status missing for five procedures
[h] Repair history missing for 14 procedures

outcomes of interest were operative time and postoperative length of hospitalization.

Statistical Analysis

Univariate analysis of demographics and operative variables were performed to describe the study population. Chi-square tests were performed to examine differences in proportions between cases based on the diagnosis of cirrhosis and the occurrence of one or more postoperative complications. Multivariable logistic regression models were used to examine the effect of cirrhosis on postoperative complications by case status. Those variables with $p<0.1$ in testing of univariate association with complications were used as main effects in logistic regression analysis. Stepwise backward elimination was employed to achieve a best-fit logistic regression model. All statistical tests were performed using Statistical Analysis Software (SAS version 9.1; SAS Institute Inc., Cary, NC).

Results

Of the 1,421 procedures available for analysis, 1,370 (97.7%) were on men, and the median age was 55 years old. Overall,

Table 2 Patient Comorbidities and Procedure Variables by Occurrence of One or More Postoperative Complications

Variable		Number of Patients	Percent	+ Complication		− Complication		Odds Ratio	95% CI	*p* Value
				N	Percent	*n*	Percent			
Overall		1,421		86	6.1	1,335	94.0			
Preoperative risk factors										
Cirrhosis	Y	127	8.9	12	9.5	115	90.6	1.7	0.9–3.3	0.09
	N	1294	91.1	74	5.7	1,120	94.3			
Smoke	Y	459	32.3	35	7.6	424	92.4	1.5	0.9–2.3	0.09
	N	962	67.7	51	5.3	911	94.7			
Alcohol abuse	Y	150	10.6	11	7.3	139	92.7	1.3	0.6–2.4	0.5
	N	1,271	89.4	75	5.9	1,196	94.1			
Chronic steroid use	Y	35	2.5	4	11.4	31	88.6	2.1	0.7–6.0	0.2
	N	1,386	97.5	82	5.9	1,304	94.1			
CHF[a]	Y	20	1.4	7	35.0	13	65.0	9.0	3.5–23.2	<0.0001
	N	1,401	98.6	79	5.6	1,322	94.4			
Diabetes	Y	152	10.7	19	12.5	133	87.5	2.6	1.5–4.4	0.0004
	N	1,269	89.3	67	5.3	1,202	94.7			
COPD[b]	Y	150	10.6	19	12.7	131	87.3	2.6	1.5–4.5	0.0003
	N	1,271	89.4	67	5.3	1,204	94.7			
Ascites	Y	72	6.1	12	16.7	60	83.3	3.4	1.8–6.7	0.0001
	N	1,349	94.0	74	5.5	1,275	94.5			
ASA class[c]										
1–2		750	52.8	23	3.1	727	96.9	3.3	2.0–5.4	<0.0001
≥3		671	47.2	63	9.4	608	90.6			
Case status[d]										
Elective		1,325	93.3	63	4.8	1,262	95.3	6.4	3.8–10.9	<0.0001
Emergent/urgent		95	6.7	23	24.2	72	75.8			
Bowel status[e]										
Compromised	Y	31	2.2	10	32.3	21	67.7	8.2	3.7–18.0	<0.0001
	N	1,385	97.8	76	5.4	1,309	94.5			
Repair history[f]										
Primary		1,302	92.5	76	5.5	1,226	94.2	1.7	0.9–3.4	0.1
Recurrent		105	7.5	10	9.5	95	90.5			
Anesthetic										
General		1,221	85.9	77	6.3	1,144	93.7	1.4	0.7–2.9	0.3
Other		200	14.1	9	4.5	191	95.5			

[a] Congestive heart failure
[b] Chronic obstructive pulmonary disease
[c] American Society of Anesthesiologists' Class
[d] Case status missing for one procedures
[e] Bowel status missing for five procedures
[f] Repair history missing for 14 procedures

Table 3 Continuous Outcomes Overall and Stratified by Case Status

	Operative Time			Postoperative Length of Stay		
	Median	IQR	*p* Value	Median	IQR	*p* Value
Overall						
Cirrhotic	1.2	1.1	0.02	4.0	5.0	0.01
Non-cirrhotic	1.0	0.9		2.0	5.0	
Elective	1.0	0.9	0.1	4.0	8.0	0.0007
Emergent	1.1	0.9		2.0	4.0	
Elective						
Cirrhotic	1.1	1.0	0.07	3.0	4.0	0.2
Non-cirrhotic	1.0	0.9		2.0	4.0	
Emergent						
Cirrhotic	1.2	0.9	0.2	5.0	9.0	0.04
Non-cirrhotic	1.1	0.8		3.0	6.0	

there was documentation of cirrhosis in 127 (8.9%) UHR procedures. History of ascites was documented within 30 days before operation in 53.5% (n=68) of patients with cirrhosis. The study population is comprised of 1,302 (92.5%) primary and 105 (7.5%) recurrent umbilical hernia repairs. Elective procedures accounted for 93.3% of the study population. There were no differences in patient gender, race, age, chronic steroid use, congestive heart failure (CHF), diabetes, or chronic obstructive pulmonary disease (COPD) based on the presence of cirrhosis (Table 1). There was a higher prevalence of smoking and alcohol abuse among cirrhotic patients. A higher proportion of cirrhotic patients underwent emergent repair (26.0% vs. 4.8% p<0.0001) and repair of a recurrent hernia (11.8% vs. 7.0% p=0.05) compared to patients without cirrhosis. A higher proportion of cirrhotic patients had indications of compromised bowel at the time of UHR (10.3% vs. 1.4% p<0.0001). Recent history of ascites was documented in 22.1% (n=28) of cirrhotics who underwent emergent repair.

Postoperative complications occurred in 6.1% (n=86) of patients undergoing UHR (Table 2). There were six deaths documented within 30-days of the operation, one of those patients had cirrhosis. Overall, patients with cirrhosis, alcohol abuse, tobacco, or chronic steroid use were no more likely to develop postoperative complications within 30 days. There was an increased incidence of complication among patients with ascites, CHF, diabetes, and COPD. Complications were more likely after emergent repair (24.2% vs. 4.8%, p<0.0001) and repair with indications of compromised bowel (32.3% vs 5.4%, p<0.0001). There was a significant association between cirrhosis and the occurrence of bowel resection (8.7% vs. 0.8%, p<0.0001), as well as emergent case status and occurrence of bowel resection (19.0% vs. 0.2%, p<0.0001). Additionally, patients with cirrhosis were more likely to return to the operating room within 30 days of UHR (7.9% vs. 2.5%, p= 0.0006). Patients who underwent emergent repair, compared to elective repair, were no more likely to return to the operating room within 30 days of UHR.

There was a significant difference in operative time and postoperative length of stay in patients with cirrhosis versus those without cirrhosis (Table 3). Additionally, postoperative length stay was greater in emergent compared to elective UHR. However, comparing only elective UHR in patients with and without cirrhosis, there was no difference in operative time or postoperative length of stay. Whereas patients with cirrhosis undergoing emergent UHR had a longer length of stay compared to non-cirrhotics undergoing emergent repair.

Best-fit logistic regression models of predictors of postoperative complications demonstrated that cirrhosis was not a significant predictor of complications in the overall study group or among elective UHR patients. However, cirrhosis was a predictor of a greater than threefold increase in complications among emergent UHR patients (Table 4). The overall model incorporates age, case status, indications of bowel compromise, smoking status, diabetes, COPD, CHF, cirrhosis, and hernia repair history. The elective and emergent models incorporates age, indications of bowel compromise, smoking status, diabetes, COPD, CHF, cirrhosis, and hernia repair history.

Table 4 Best-Fit Regression Models of Morbidity After Umbilical Hernia Repair by Case Status

Variable	Odds Ratio	95% CI
Overall model		
Emergent/urgent case	5.4	3.1–9.4
History of CHF[a]	4.0	1.4–11.4
Diabetes	2.1	1.2–3.8
History of COPD[b]	2.0	1.1–3.6
Elective model		
Diabetes	2.2	1.2–4.2
History of COPD	2.1	1.1–4.0
Emergent model		
History of CHF	11.8	1.7–81.7
Cirrhosis	4.4	1.3–14.3
History of COPD	3.7	1.0–14.2
Diabetes	3.7	0.9–15.1

[a] Congestive heart failure
[b] Chronic obstructive pulmonary disease

Discussion

In this multi-site study, we found that elective UHR in cirrhotics is safe and associated with similar outcomes as in patients without cirrhosis. We found that patients with cirrhosis were more likely to undergo emergent UHR. Patients with cirrhosis had poor outcomes after emergent UHR, and cirrhosis is a significant predictor of postoperative complications after emergent UHR.

Our data demonstrates that cirrhosis is not a significant predictor of postoperative complications for the overall study population or patients undergoing elective UHR. Prior studies have documented increased morbidity and mortality among cirrhotic patients undergoing emergent surgery.[5,9,10] A previous study demonstrated an increased incidence of emergent hernia repair among cirrhotic patients, as well as increased complications, hospital resource utilization, and mortality.[8] Our data demonstrates that cirrhosis is a significant predictor of postoperative complications after emergent UHR only. Other studies have demonstrated that cirrhotic patients tolerate elective hernia repair, especially if ascites is controlled preoperatively.[14,15] Our study supports elective repair of umbilical hernias among cirrhotic patients.

We found a significant association between cirrhosis and bowel resection, likely due to the incidence of strangulation, incarceration, and obstruction leading to the emergent UHR. We have previously shown that the occurrence of an enterotomy or bowel resection in elective incisional hernia repair is associated with increased postoperative complications, rate of return to the operating room, operative time, and postoperative length of stay.[16]

Our models of postoperative complications illustrate the role of diabetes and COPD on the development of complications regardless of case status. Previous studies have found that hyperglycemia is an independent predictor of short-term infectious complications.[17,18] Among critically ill patients, intensive insulin therapy (glucose level less than 110 mg/dl) is associated with decreased incidence of blood stream infections, acute renal failure, blood transfusion, ventilator support, intensive care utilization, and reduced overall in-hospital mortality.[19] Other studies have shown COPD to be an independent risk factor for the development of surgical site infections.[20,21] Our data reinforces the importance of optimizing medical comorbidities before UHR.

Our study has several limitations. The incidence of cirrhosis was ascertained from administrative data and likely underestimates the true incidence. Similarly, the mortality data was ascertained from administrative data and may underestimate the mortality rate. Unfortunately, a number of cirrhotic patients are missing preoperative lab values, which limits our ability to classify the degree of hepatic impairment among the cirrhotic patients. Finally, the incidence of postoperative complications in elective umbilical hernia repair is low, and we may lack power to detect a difference in complications between patients with and without cirrhosis in the elective subgroup.

Conclusion

We found that elective UHR in cirrhotics is safe and associated with similar outcomes as in patients without cirrhosis. However, emergent repair of UHR in patients with cirrhosis is associated with worse outcomes. Early elective repair of umbilical hernias may improve the overall outcomes for patients with cirrhosis.

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References

1. Baron HC. Umbilical hernia secondary to cirrhosis of the liver. Complications of surgical correction. N Engl J Med 1960;263:824–828.
2. Belghiti J, Durand F. Abdominal wall hernias in the setting of cirrhosis. Semin Liver Dis 1997;17(3):219–226.
3. Muschaweck U. Umbilical and epigastric hernia repair. Surg Clin North Am 2003;83(5):1207–1221.
4. de la Pena CG, Fakih F, Marquez R, Dominguez-Adame E, Garcia F, Medina J. Umbilical herniorrhaphy in cirrhotic patients: a safe approach. Eur J Surg 2000;166(5):415–416.
5. Garrison RN, Cryer HM, Howard DA, Polk HC Jr. Clarification of risk factors for abdominal operations in patients with hepatic cirrhosis. Ann Surg 1984;199(6):648–655.
6. Pescovitz MD. Umbilical hernia repair in patients with cirrhosis. No evidence for increased incidence of variceal bleeding. Ann Surg 1984;199(3):325–327.
7. O'Hara ET, Oliai A, Patek AJ Jr, Nabseth DC. Management of umbilical hernias associated with hepatic cirrhosis and ascites. Ann Surg 1975;181(1):85–87.
8. Carbonell AM, Wolfe LG, DeMaria EJ. Poor outcomes in cirrhosis-associated hernia repair: a nationwide cohort study of 32,033 patients. Hernia 2005;9(4):353–357.
9. Aranha GV, Greenlee HB. Intra-abdominal surgery in patients with advanced cirrhosis. Arch Surg 1986;121(3):275–277.
10. Doberneck RC, Sterling WA Jr, Allison DC. Morbidity and mortality after operation in nonbleeding cirrhotic patients. Am J Surg 1983;146(3):306–309.
11. Khuri SF, Daley J, Henderson W et al. The Department of Veterans Affairs' NSQIP: the first national, validated, outcome-based, risk-adjusted, and peer-controlled program for the measurement and enhancement of the quality of surgical care. National VA Surgical Quality Improvement Program. Ann Surg 1998;228(4):491–507.
12. Khuri SF, Daley J, Henderson WG. The comparative assessment and improvement of quality of surgical care in the Department of Veterans Affairs. Arch Surg 2002;137(1):20–27.
13. Murphy PA, Cowper DC, Seppala G, Stroupe KT, Hynes DM. Veterans Health Administration inpatient and outpatient care data: an overview. Eff Clin Pract 2002;5(3 Suppl):E4.

14. Ozden I, Emre A, Bilge O et al. Elective repair of abdominal wall hernias in decompensated cirrhosis. Hepatogastroenterology 1998;45(23):1516–1518.
15. Fagan SP, Awad SS, Berger DH. Management of complicated umbilical hernias in patients with end-stage liver disease and refractory ascites. Surgery 2004;135(6):679–682.
16. Gray S, Vick C, Graham L, Finan K, Neumayer L, Hawn M. Enterotomy or unplanned bowel resection during elective hernia repair increases complications. Arch Surg (in press).
17. Golden SH, Peart-Vigilance C, Kao WH, Brancati FL. Perioperative glycemic control and the risk of infectious complications in a cohort of adults with diabetes. Diabetes Care 1999;22(9):1408–1414.
18. Latham R, Lancaster AD, Covington JF, Pirolo JS, Thomas CS. The association of diabetes and glucose control with surgical-site infections among cardiothoracic surgery patients. Infect Control Hosp Epidemiol 2001;22(10):607–612.
19. van den Berghe G, Wouters P, Weekers F et al. Intensive insulin therapy in the critically ill patients. N Engl J Med 2001;345 (19):1359–1367.
20. Kaye KS, Sloane R, Sexton DJ, Schmader KA. Risk factors for surgical site infections in older people. J Am Geriatr Soc 2006;54 (3):391–396.
21. Rovera F, Imperatori A, Militello P et al. Infections in 346 consecutive video-assisted thoracoscopic procedures. Surg Infect (Larchmt) 2003;4(1):45–51.