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Clinical Article

Relationship of Glucose Control and Wound Infection in Diabetics after Lumbar Spine Surgery

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Objective : The purpose of this study is to investigate the elevated blood glucose levels in the postoperative period are associated with an increased risk of deep wound infection in diabetic individuals undergoing lumbar spine surgery.

Methods : Of 2896 patients who underwent lumbar spine operations by one surgeon between 1993 and 2002, 329(11.4%) were diabetics. The rate of deep wound infections in diabetic patients was 6.4%, versus 3.2% for nondiabetics. 152 patients had their operation before implementation of the protocol and 177 after implementation. Charts of the diabetic patients were reviewed. Mean blood glucose levels were calculated from documented results of finger-stick glucometer testing.

Results : Twenty-one diabetic patients suffered deep wound infection. Infected diabetic patients had a higher mean blood glucose level through the first 2 postoperative days than noninfected patients(230 ± 6.9 versus 175 ± 3.8mg/dL; $p<0.003$) and had a long operation time(216 ± 57.9 versus 167.5 ± 42.2 minute; $p<0.05$). Multivariable logistic regression showed that mean blood glucose level for the first 2 postoperative days, long operation time, and use of the instrumentation($p<0.02$) were all related predictiors of deep wound infection. Institution of a protocol of postoperative continuous intravenous insulin to maintain blood glucose level less than 200mg/dL was began in september 1997. This protocol resulted in a decrease in blood glucose levels for the first 2 postoperative days and a concomitant decrease in the proportion of patients with deep wound infection, from 8.3%(11/132) to 5.1%(10/195) ($p<0.02$).

Conclusion : The incidence of deep wound infection in diabetic patients is reduced after implementation of a protocol to maintain mean blood glucose level less than 200mg/dL in the immediate postoperative period.

KEY WORDS : Glucose control · Wound infection · Diabetics.

Introduction

Intensive diabetic therapy with improved blood glucose control has been shown to delay the long-term detrimental effects of microvascular complications and to prevent impairment of the ability of leukocyte ability to phagocytose and effectively kill bacteria[5,8].

The importance of defects in leukocyte function in diabetics was addressed in 1982 by Rayfield and associates, who showed a significant positive correlation between mean plasma glucose levels and the frequency of acute infection[7]. The diminution of intracellular bactericidal activity of leukocytes to both Staphylococcus aureus and Escherichia coli was shown to have a direct relation to glucose control.

Studies by Hennessy and colleagues showed the detrimental effects of short-term hyperglycemia on the ability of immunoglobulin G to fix complement, one aspect of antimicrobial immune function[3].

Despite the number of publications in which risk factors for deep wound infection in diabetic patients having undergone spianl surgery have been detailed, the nature and magnitude of these risk factors is not clear. The majority of studies of deep wound infection after spinal surgery in the literature have only been descriptive, lacking statistical analysis of association between potential risk factors in diabetics and infection.

We report the experience at our institution with diabetics who underwent lumbar spine surgery in an effort to evaluate how glucose control have had an impact on the wound infection.

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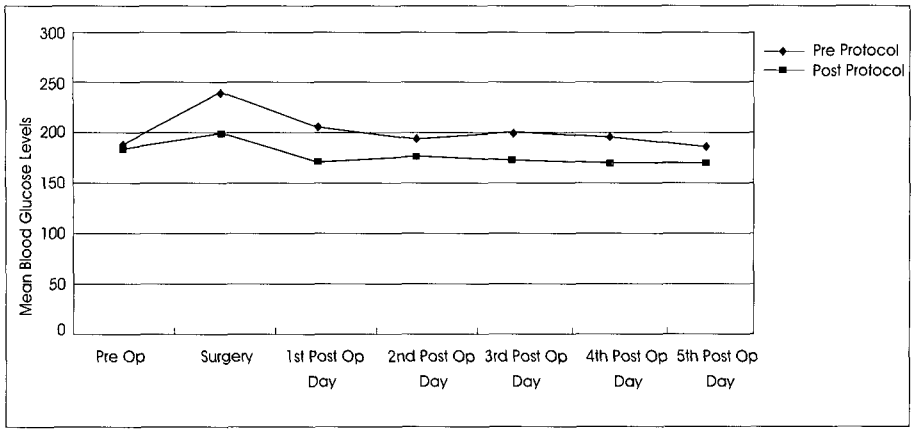

Fig. 1. Mean blood glucose levels in all diabetic patients before and after implementation of the diabetic protocol.

Materials and Methods

Clinical methods

A diabetic protocol was designed and implemented that standardized the titration of intravenous insulin to maintain the mean blood glucose level less than 200mg/dL. Blood glucose levels were determined by glucometer measurements, and insulin was titrated by critical care nurses. There were no changes in antibiotic protocols during this time, and procedures were performed by the same surgical group. Data were collected by retrospective chart review on all diabetic patients who had lumbar spine operations by one surgeon between 1993 and 2002 at our institution. Table 1 shows baseline data for the patients before and after implementation of the protocol. Daily mean blood glucose levels were calculated by averaging the levels obtained clinically by finger stick every 6 hours and were recorded in the medical record. Levels were compared before and after implementation of the diabetic protocol, and patients with deep wound infections were compared with those who did not become infected.

Table 1. Comparison of Patients Before and After Implementation of Diabetic Protocol

Variable	Before protocol (n=152)	After protocol (n=177)
Not found significiant(p>0.05)		
Age	54	58
Sex-male	62%	60%
Diabetes type		
Insulin dependent	25%	28%
Oral agent	59%	57%
Diet only	11%	10%
No treatment	6%	6%
Redo operation	12%	9%
PRC transfusion	13%	11%
Significiant(p<0.05)		
Long time operation	24%	26%
Metalic instrumentation	35%	33%
Status at operation		
Elective	87%	92%
Emergent	13%	8%

Statistical methods

Multiple variables were considered as possible predictors of deep wound infection. Variables and their univariate significance were as follows : average blood glucose 48 hours after operation(p=0.0024); mean blood glucose level on first postoperative day(p=0.003); mean blood glucose level on second postoperative day(p=0.0163); use of metallic instrumentation (p=0.0183); operation before or after protocol implemented(p=0.077); diabetes requiring insulin or oral agents(p=0.2256); reoperation(p=0.2519); status at time of operation(p=0.2548); packed red blood cells transfused (p=0.2551). Univariate and multiple logistic regression analyses were used to develop a model to predict the risk of deep wound infection for each patient. Analysis was done by paired t test, and multivariable logistic regression using SPSS (Chicago, IL) statistical software.

"Deep wound infection" included discitis, epidural abscess, and spondylitis. "Diabetic patients" included those who were insulin dependent and non? insulin-dependent at the time of operation. "Long operation time" denoted one that operation time was over the 150 minutes. "Elective status at operation" denoted one that was perf-ormed with scheduled. Cases are usually scheduled at least 3 days before the surgical procedure. "Emergent status at operation" denoted cases that permitted no delay in operative intervention. Patients requiring emergency operation had ongoing neurologic deficit, cauda equina syndrome.

Clinical material

In all, 2,896 patients underwent lumbar spine operations between 1993 and 2002 due to back pain, radiating pain or neurogenic intermittent claudication; 329 were diabetic (11.4%) : 35% insulin dependent, 47% taking oral agents, 10% diet controlled, and 6% on no treatment before admission. The mean age was 56±9.7 years; 61% (201/329) were male. 229

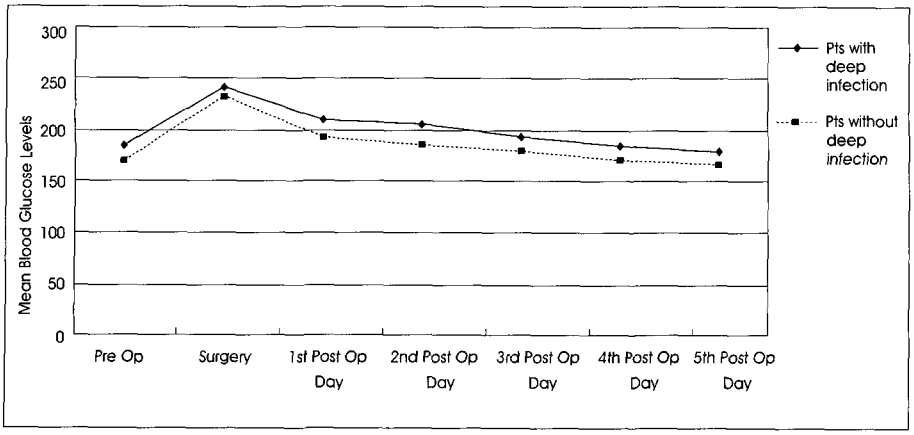

Fig. 2. Comparison of mean blood glucose levels in daibetic patients with and without deep wound infection(includes discitis, epidural abscess, and spondylitis).

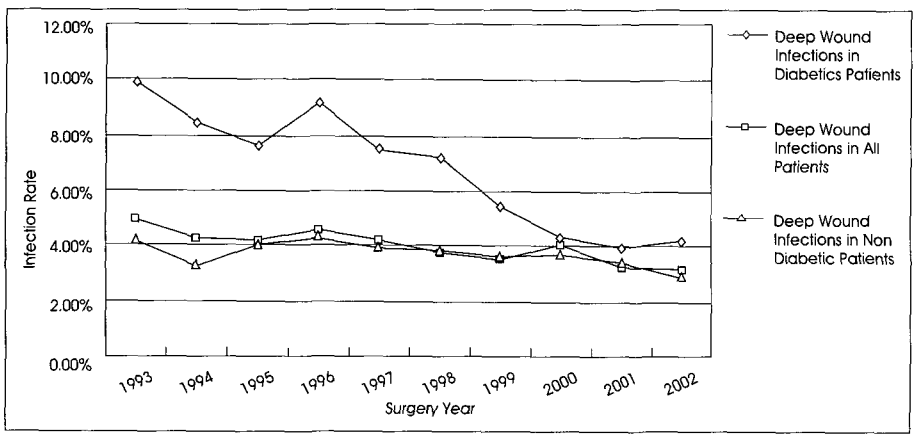

Fig. 3. Deep wound infection in patients having lumbar spinal operation

patients underwent laminectomy or disectomy. 110 patients performed spinal instrumentation and fusion. 21 patients suffered deep wound infections (6.4%) : discitis in ten and epidural abscess in seven and spondylitis in four.

Results

Implementation of the diabetic protocol in September 1997 resulted in a decrease in the mean basal glucose levels on the first postoperative day (206 versus 172mg/dL; $p< 0.005$) and the second postoperative day (195 versus 176mg/dL; $p< 0.002$) (Fig. 1), and over 48 hours (201 versus 174mg/dL; $p< 0.003$). Glucose levels were measured by glucometer tests, as indicated in the protocol. The rate of deep wound infection in diabetic patients dropped from 9.9% in 1993 to 4.2% in 2002, the fifth year after implementation. When measured over a 5-year period before implementation of the diabetic protocol, the rate in diabetic patients was 8.3% versus 5.1% in the 5 years after implementation. In nondiabetic patients, the 5-year rate was 3.8%, versus 3.1% for the 5 years after implementation.

Elevated blood glucose at 48 hours was found to be significantly associated with an increased risk of deep wound infection ($p< 0.002$)(Fig. 2). When looked at over time, the rate of infection in diabetic patients dropped after implementation of the diabetic protocol(Fig. 3).

Univariate regression analysis of variables considered as possible predictors of deep wound infection in diabetic patients revealed the following to be significant at $p<0.05$: average blood glucose at 48 hours, blood glucose on the first and second postoperative days, and application of metallic instrumentation and long operation time. Variables in the multivariable predictive model found to be significant at $p<0.05$ were mean blood glucose levels at 48 hours greater than 200 mg/dL, and use of metallic instrumentation.

Postoperative blood glucose and the deep wound infection rate showed a significant direct relation ($p = 0.002$)(Fig. 4). This model demonstrates the ability to identify diabetic patients at higher risk of deep wound infection after lumbar spinal surgery.

Discussion

Deep wound infection in lumbar spine surgery causes increased mortality, lengthy hospital stays, repeated trips to the operating room, and greater hospital costs, not to mention the pain and suffering of patients and their family during prolonged convalescence.

Contrary to common belief, the association between diabetes mellitus and increased susceptibility to infection in general is not supported by strong evidence. However, many specific infections are more common in diabetic patients, and some occur almost exclusively in them[4,9,11]. Other infections occur with increased severity and are associated with an increased risk of complications in patients with diabetes.

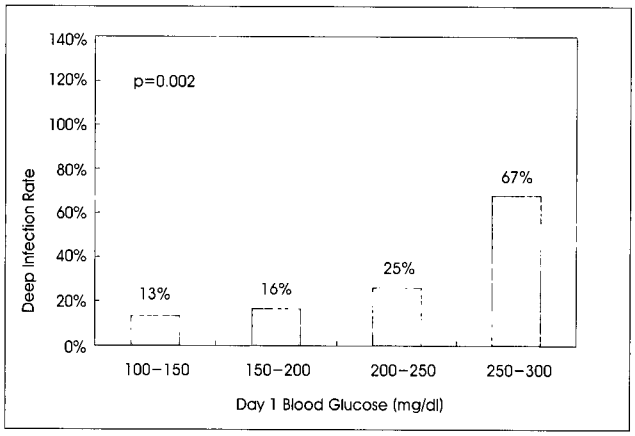

Fig. 4. Significant direct relation shown between postoperative blood glucose level and deep infection rates.

Several aspects of immunity are altered in patients with diabetes. Polymorphonuclear leukocyte function is depressed, particularly when acidosis is also present. Leukocyte adherence, chemotaxis, and phagocytosis may be affected[1,2,10]. Antioxidant systems involved in bactericidal activity may be[6]. The clinical data on humoral immunity are limited, but responses to vaccines appear to be normal. Cutaneous responses to antigen challenges and measures of T-cell function may be depressed.

Although these in vitro findings have not yet been fully confirmed in clinical studies, there is evidence that improving glycemic control in patients improves immune function. For example, the efficiency of intracellular killing of microorganisms may improve with better glycemic control[2].

What has not been shown in clinical practice is the effect of intensive control of basal glucose levels in diabetic patients in the postoperative period. We hypothesize that elevated basal glucose levels after lumbar spine operations in diabetic patients are associated with a higher incidence of infectious complications. The 5-year rate of deep wound infection in patients having lumbar operations at our institute was two times higher in diabetics than in nondiabetics. The diabetic protocol was proven successful in lowering the mean blood glucose levels in the immediate postoperative period. The decrease in infection rates for patients with average basal glucose levels less than 200mg/dL on the first postoperative day was significant (p=0.018). The rate of deep wound infection in diabetics has decreased since implementation of the protocol, whereas the rate in nondiabetic patients remains stable at less than 1%; this shows that the decrease is likely not due to other factors.

This is a study using retrospective chart review. We recognize the inherent problems of lack of recognition of important variations among patient populations and the potential bias to which this type of investigation may be prone. However, we believe that the significant impact on mean basal levels with use of the protocol is a determining factor in the dramatic decrease in our infection rates. We are confident that the decreased rates before and after implementation of the protocol (p = 0.14) will show higher significance as more patients are added to the study.

Conclusion

Using multivariate analysis and a retrospective case control study design, we have shown that the incidence of deep wound infection in diabetic patients was reduced after implementation of a protocol to maintain mean blood glucose level less than 200mg/dL in the immediate postoperative period.

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