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Importance of Monitoring Creatine-kinase in Spinal Surgery

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Abstract

Creatine-kinase (CK) is the most widely used enzyme to diagnose and follow muscle disease. This study confirms the validity of postoperative Creatine-kinase (CK) values as an indicator of muscle lesion, assess the relationship of CK with variables indicating surgical invasiveness and investigate an association between CK values and excessive postoperative pain. CK values were higher in men and in younger patients. Significant correlations were found between CK and the number of fused levels and duration of degenerative lumbar spine surgery.

Keywords: Lumbar spine surgery; Creatine kinase; Muscle injuries

Introduction

Spine surgery is known for its invasive surgical approaches. Muscle damage can be extensile despite all precautions that can be taken, not only from direct trauma during the operative procedure, but also from prolonged immobilization required [1]. The changes occurring in the paraspinal musculature following spine surgery have been related to the degree of postoperative pain [2,3]. Serum Creatine-kinase (CK) level in the immediate postoperative period has been considered a suitable parameter for estimating muscle injury in various spinal procedures [4]. CK level significantly correlates with the length and depth of the surgical dissection [5], and a significant relationship has been found between serum values of this enzyme and the duration and intensity of the pressure on paraspinal muscles exerted by retraction [4,6,7].

Methods

This retrospective study included 100 patients with degenerative lumbar spine disease between 2015 and 2017. The cases were selected such that 40 patients were operated in lateral position and 60 in prone or supine position. Serum CK concentration was determined on the first postoperative day. Data on the number of levels fused, the duration of surgery, and operative bleeding were recorded in each patient. The procedure involved posterior midline incision; paravertebral musculature was detached from vertebral arches and retracted laterally; then an instrumented fusion and, where it was considered indicated, a decompression was performed. We collected for each patient data (age, sex, weight and comorbidities), surgery related data (operating time, number of fused levels), and duration of hospitalization. All patients received analgesic treatment according to our established protocol, consisting of intravenous administration of metamizole 2 g/6 hours and paracetamol 1 g/6 hours. The number of analgesia doses needed by each patient in the first 72 hours was recorded. First day following intervention, serum CK levels were determined (normal values 32294 IU/L for men and 33-211 IU/L for women), also C-reactive Protein (CRP) concentrations were recorded (normal values: 0, 5-3 mg/L). The variable CK serum levels underwent logarithmic transformation to obtain a normal distribution. Statistical analyses included a "t" test to analyze differences between two mean values. The chi-square test was used to compare percentages. For the correlation analyses, Pearson's coefficient was determined. Significance was set at $p<0.05$.

Results

The study included 100 patients (55 women and 45 men) with a mean age of 61.5 years. The diagnoses were spinal stenosis in 59 cases (59%), degenerative disc disease in 26 cases (26%), spondylolisthesis in 10 cases (10%), and degenerative lumbar scoliosis in 5 cases (5%). The mean CK value at one day following surgery was 1298.3 IU/L, and the median was 656 IU/L. The upper limit of normality of CK established in our laboratory is 293 IU/L. The patients presented a mean CK elevation of 4-fold the upper reference limit (range, 0.4-fold to 20.5-fold). However, the median was 2.2-fold higher, and only 30% of patients presented CK values 4-fold higher than the upper normal limit. Mean duration of hospitalization was 8.5 days (median 7 days, range 2-64 days) and 87.5% of patients were discharged before 10 days. Postoperative CK level negatively correlated with age ($r=-0.2$, $p=0.03$). The highest values were seen in the youngest patients (CK values: patients <50 years 1794 IU/L; patients 50-70 years 1161 IU/L; patients >70 year 940 IU/L; $p=0.05$). Furthermore, CK levels were higher in men (1644 IU/L) than in women (844 IU/L) (t-test, $p=0.002$). A statistically significant correlation was found between CK values and the number of fused levels ($r=0.45$, $p=0.0001$), operating time ($r=0.5$, $p=0.0001$), and CRP concentration at 24 hours ($r=0.4$, $p=0.0001$). In contrast, there was no correlation with BMI ($r=0.1$) or duration of hospitalization ($r=0.1$).

Discussion

Several authors have reported an association between postoperative CK level and pain intensity in the immediate postoperative period (22) and at middle term (2,27). Lumbar spinal surgery led to an increase in CK values greater than twice the upper reference limit in more than half the patients in our study. CK levels were higher in younger patients and in males. Statistically significant correlations were found between serum CK levels and variables related to surgical intervention (the number of fused levels and operating time), so it is a valid parameter to estimate the aggressiveness of the surgical intervention regardless of patient's age or sex. There was no association with the duration of hospitalization. CK has been considered a suitable indicator of muscle injury following various surgical procedures of the spine [4]. In our research, the total CK level was determined, not the skeletal-muscle isozyme, CK/MM, taking into account the findings of Kumbhare et al. [5]. These authors demonstrated that in patients undergoing posterior spinal surgery, the MM fraction accounts for virtually the entire CK

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value both preoperatively and at the postoperative peak. In some previous studies, postoperative CK levels have been associated with the size of the dissection, such that in more aggressive procedures, the values of this enzyme are elevated [2,4,5,8]. There is, however, controversy around this point because other authors have reported elevated CK values following procedures involving minor surgical aggression [9]. It has also been found that the pressure exerted by the retractors on the paraspinal musculature and the operating time influence serum CK values [6,10]. A reduction in blood supply to the muscles caused by compression could explain this finding [11,12]. CK levels can be affected by several patient-related variables, such as the muscle mass, liver function, and age [13]. The muscle mass depends on the amount of physical activity and is influenced by a person's sex [14] and weight [15]. Higher postoperative CK values have been found in men [16], as seen in our study. With increasing age, there is a decrease in the paraspinal musculature as muscle fibers are replaced by fibrous tissue or fatty infiltration, which leads to a reduction in the effective muscle area [15]. Our finding of a negative correlation between serum CK values and age supports this concept. The relationship between invasiveness of surgery and the duration of postoperative pain is also a subject of debate. It has been suggested that persistent postoperative low back pain at middle term may be related to the trophic changes observed in the paraspinal musculature following surgery, although the discussion is controversial. Gejo et al. [11] reported that patients with greater involvement of the paraspinal muscles assessed by Magnetic Resonance Imaging (MRI) presented a higher incidence of low back pain at six months following surgery. Fan et al. [17] found a significant relationship of pain with disability and degree of spinal muscle atrophy determined by MRI at one year. No correlations were found between muscle changes and pain intensity either in patients treated with a first surgery or those undergoing revision surgery. The authors concluded that factors other than muscle injury should be considered to explain the persistent pain. It seems clear that more invasive surgery, as established by operating time and the number of treated vertebral segments, causes greater muscle injury, which can be evaluated by serum CK levels. However, the published data are not conclusive as to whether the degree of muscle injury is related to the degree of pain postoperatively and at middle term. By reducing the skin incision and/or extent of dissection using minimally invasive surgery, there will be less tissue injury, with a secondary decrease in postoperative pain, shorter duration of hospitalization [8,18], and faster return to normal daily activity [19]. One study compared CK levels in 3 groups postoperatively: group A included spine surgery in the knee chest position, group B neurosurgery without any muscle stretching, and group C abdominal surgery with retractors [20]. CK levels were significantly higher in groups A and C. Kawagushi et al. evaluated intraoperative factors for back muscle injury and found positive correlation with retraction pressure, time, and extent of exposure [6]. CK is increased after surgery and reached a plateau by day 1, followed by return to normal within one week. CK elevations following spine surgery is significantly higher in men than in women, most probably due to muscle mass difference [17]. Serum CK level is significantly correlated to the severity of surgery-induced tissue damage. It increases gradually after incision [21]. Decreased muscle strength and atrophy is typical after back surgery, as was demonstrated by Mayer et al. through a CT scan evaluation of back muscles in 44 patients 3 months after lumbar surgery [22]. Suwa et al. also evaluated postoperative changes in paraspinal muscles in 89 patients (42 single interlaminar level procedures, 13 multiple levels, and 34 posterolateral fusion procedures). They found that paraspinal muscle thickness significantly decreased in the third group [23]. Kumbhare et al. studied muscle injury in lumbar surgery. Through a progressive evaluation of serum CK in 12 patients, the authors found that time to CK peak ranges between 9 to 47 hours postoperatively [24].

Conclusions

The results of this study indicate that serum CK values in the immediate postoperative period enable estimation of the surgical aggression on the paraspinal musculature during posterior spinal surgery. We did not find a significant relationship between the levels of this enzyme and immediate postoperative pain. Total CK remains the best cost-effective measurement to estimate muscle damage following spine surgery. More prospective trials are needed for a better conclusion.

Conflict of Interest

Authors have no conflict of interest to disclose.

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