DIABETES AS RISK FACTOR OF SURGICAL SITE INFECTION IN LUMBAR SPINE SURGERY WITH ARTIFICIAL IMPLANTS - OVERVIEW OF CURRENT KNOWLEDGE AND EXPERIENCE OF OUR DEPARTMENT

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ABSTRACT

Diabetes mellitus is a common metabolic disease, occurring mainly in the adult population, with the incidence increasing with age. It is an area of interest for diabetologists and internists. Due to its prevalence, it occurs in patients operated by neurosurgeons for spinal stenosis. Spinal stenosis causes neuropathic pain and other radicular symptoms which may be intensified due to diabetic neuropathy. Diabetes is an additional risk factor in any neurosurgical procedure for general (impaired wound healing) and anesthetic reasons. The specificity of neurosurgical lumbar spine procedures allows to elect simple nerve structures decompression, or supporting it with spine implant. The subject of our analysis is whether permanent spine implants should be absolutely avoided in diabetic patients, as long as they are elective and do not have to be inserted. Rather, it is observed in clinical practice that neurosurgeons tend to avoid implants in diabetic patients unless implants are essential. The aim of our report is put attention to this aspect. There are only single literature data that diabetes is a risk factor for spine implants but there are no clear conclusions in majority of references. The authors conclude that assessing how safely spinal implants can be used in diabetics requires long-term prospective studies, as current standards of care are based on the experience of neurosurgeons.

Keywords: implants, diabetes, surgical infection, lumbar surgery

I. INTRODUCTION

In Poland, about 2.5 million people (6.54% of the population) suffer from diabetes mellitus (DM). DM is a social disease and morbidity is constantly growing. It is believed that in 2030 approximately 360 million people in the world will suffer from DM, mainly in economically developed countries [1]. It also means that patients with DM visit their physicians for other conditions, such as spinal stenosis, potentially requiring a neurosurgical procedure (and potentially to consider with implants instrumentation). There are two types of DM - the first type and the second type [1-3]. Type 1 DM is less frequent, the incidence is 0.3% and it occurs in patients <30 years of age. Type 2 DM is much more common, the incidence is 1.6 - 4.7%, it occurs in elderly people [2]. The incidence of the disease increases until the age of 70. It is estimated that the incidence of type 2 DM in Poland is 200 per 100,000 people [1,2]. Type one DM is treated with insulin and type two DM is treated with oral medications [2]. Patients with DM who receive treatment from a neurosurgeon for diseases of the spine that require surgery are most often patients with type 2 DM. You should also be aware that more than 30% of diabetic patients have undiagnosed DM [2,3]. This means that over 750,000 people have DM but are not treated [3]. This is not beneficial from a health point of view. DM causes systemic complications, including neuropathy [3]. Neuropathy is the nervous system dysfunction, including sensory disturbances: paresthesia, neuropathic pain and radicular pain [4]. The symptomatology of diabetic neuropathy may resemble those of spinal stenosis. Therefore, there are both patients with diabetic neuropathy without significant spinal stenosis (but they can be confused and the symptoms attributed to the spine) and patients whose symptoms from the spine are exacerbated by diabetes.

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This is potential difficulty in differential diagnosis for the neurosurgeon when surgery qualifying. The topic of diagnostic dilemmas are a separate issue (interesting and requiring further analysis), however it exceeds the pages of this manuscript. In this paper, we want to present the issue of using elective implants in diabetic patient operated due to spinal stenosis (regardless of qualifications). DM is potentially conducive to disturbed wound healing and surgery site infection (SSI) [4]. Generally, every surgeon, regardless specificity, has in mind the disturbed healing process and purulent infection. It is imperative that DM parameters must be correct before the planned surgical treatment. The patient must have relatively normal glycemic level and glycated hemoglobin (HbA1C) is measured prior to the surgical procedure [4,5]. This parameter is important in terms of the risk of potential perioperative complications [5] because it is a useful retrospective glycemic index as there is an association between HbA1C and mean glycemia and the risk of chronic diabetic complications [6]. Therefore, elevated AbA1C level is reason to postpone surgical procedure [4-6], including neurosurgical spine procedures (regardless of the possible intention to implant an implant).

The aim of our study was to present our own experiences on elective spine implants using in diabetic patients and to try to answer the question: Is diabetes a contraindication to the use of such implants?

II. MATERIAL AND METHODS

The analysis included patients treated surgically for lumbar stenosis in 2020 in Neurosurgical Department of Collegium Medicum in Nicolaus Copernicus University (Bydgoszcz, Poland). In lumbar stenosis surgical procedures using spinal implants is potentially elective in particular cases. Patients operated due to cervical discopathy, lumbar spondylolisthesis, spinal cord stimulation and injuries were not taken into account, as the use of implants is obligatory in this group. The analyzed group consisted of patients with lumbar degenerative stenosis or degenerative spondylolisthesis: in these patients, the strategy of surgical treatment is decompression, and fusion or using interspinous distraction is elective (additional) surgical option. According to many authors, there are no significant differences in the results of surgical treatment in the case of decompression vs decompression + instrumentation.

In our study, patients with lumbar spine treated surgically were taken into account. ICD-10 codes of diagnoses used for analysis were: M47.2 and M51.1. In 2020, 52 patients with the diagnosis M47.2 and 295 with the diagnosis M51.1 were operated on. The ICD-10 M47.2 group consisted of patients with degenerative stenosis, and M51.1 patients with disc herniation. The authors emphasize that in some cases the essence of the disease in groups M51.1 and M47.2 is blurred. The mean age of patients diagnosed with M47.2 was 64.87 years and those diagnosed with M51.1 48.76 years. Therefore, a total of 347 patients (197 women, 150 men) were operated on due to stenosis of the lumbar spine with the nerve roots compression. DM as a comorbid disease was found in 27 patients (7.78%). In 25 cases it was type 2 DM and in two cases it was type 1 DM. Surgical procedures were also taken into account, including the use of implants. Two groups of surgical procedures were analyzed according to homogeneous groups of patients (pol. jednorodne grupy pacjentów, JGP). Among the analyzed JGPs, spine procedures without the use of implants - A22 constituted 153 procedures, while H52 (i.e. with an implant) 70, among them 56 procedures were 84.58, i.e. an interspinous spacer (ISS) implantation. The ISS was the only elective spinal implant in the study group, which is quite an important, albeit secondary, conclusion in this manuscript.

Much of the lumbar spine surgery allows for the elective use of implants. When operating degenerative spine disease, neurosurgeon can perform a simple decompression or sometimes additionally use implants (transpedicular screws, interbody or interspinous implants). There is no clear evidence that the use of these implants unequivocally improves the outcome. Therefore, their use is at the discretion of the neurosurgeon. Some of them avoid implants and promote "natural" surgical techniques without foreign bodies. Some neurosurgeons in turn prefer to use implants and instrumentation. In our department, we use a centered model of surgical techniques, but we tend towards non - implant procedures, as long as it is possible to perform a simple decompression.

Among patients with DM, it was decided to implant an ISS implant in only two patients. They were patients (1M, 1F) with a mean age of 81.38 years with type 2 DM. They presented symptoms of neurogenic claudication, with the typical symptom of a "supermarket basket" in which flexion of lumbar spine relieves the symptoms. Due to the generalized stenosis of the intervertebral foramen, most severe on L3-L5, the major benefit of ISS was

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decided along with the minimal central flavectomy, as little invasive as possible. In the remaining DM patients, we avoided using of ISS (and any other elective spine implants).

III. RESULTS

Based on the above analysis, we conclude that we generally avoid the use of implants in spine surgery in DM patients, unless they are mandatory. Implant placement may be considered if it seems to be of key importance in the treatment strategy (ISS in neurogenic claudication in old age).

IV. DISCUSSION

We reviewed the literature about SSI in lumbar surgery of DM patients putting emphasis on spine implants. We found no reference positions about SSI in surgery without implants vs surgery supported by elective spine implants (such studies would be ethically ambivalent - because authors would have to consciously use elective implants in patients with DM being aware that, according to the references, this means a increased risk of SSI).

Hikata et al. (2014) noted that DM was reported to be a risk factor for SSI, which was a serious complication after spinal surgery [7]. According to Hikata et al., effect of DM on SSI after instrumented spinal surgery remains to be clarified [7]. This confirmed that seven years prior to this article publication (2014 till 2021) there were no clear evidences of the effect of implants on the increased risk of SSI. Hikata et al. Described elucidated perioperative risk factors for SSI after posterior thoracic and lumbar spinal arthodesis with instrumentation in patients with DM. He included 36 patients with DM (19 males and 17 females; mean age 64.3 years). The patients’ medical records were retrospectively reviewed to determine the SSI rate. The characteristics of the DM patients were examined in detail, including the levels of serum glucose and HbA1c [7]. Hikata et al. noted that patients with DM had a higher rate of SSI than patients without DM (16.7% vs 3.2 %) [7]. He emphasized that, although the perioperative serum glucose level did not differ between DM patients that did or did not develop SSI, the preoperative HbA1c value was significantly higher in the patients who developed SSI (7.6 %) than in those who did not (6.9 %). Hikata et al. concluded that to prevent SSI in DM patients, it was recommend lowering the HbA1c to <7.0 % before performing surgery [7].

Liao et al. (2006) emphasized that DM was thought to be a risk factor for SSI [8]. He noted in 2006 that there had been no reports about the infection rate in diabetic patients who had undergone spinal surgery with implants used [8]. Liao et al. presented a retrospective analysis of infection rates after posterior spinal instrumented fusion in diabetic and non - diabetic patients [8]. Analysis performed by Liao et al. it was different from our study. In our manuscript we wanted to compare the risk of SSI in patients with DM after lumbar surgery (no implant vs with implant), while Liao compared lumbar surgery with implants in patients (no DM vs DM). Liao et al. described 337 patients, 11.57% of them (n = 39) were diabetic [8]. All patients included to Liao’s et et. study underwent posterior spinal instrumented fusion (1995 – 1997) [8]. Liao et al. concluded that patients with a diabetic history or preoperative hyperglycemia had a higher infection rate after posterior spinal instrumented fusion when compared with non - diabetic patients [8].

Friedman et al. (2007) performed case - control study and examined risk factors for SSI following spinal surgery and analyzed the associations between a surgeon's years of operating experience and surgical specialty and patients’ SSI risk [9]. He described 41 case patients with SSI complicating laminectomy and 82 matched control patients [9]. Friedman et al. concluded that DM, obesity, and laminectomy at a level other than cervical are independent risk factors for SSI following laminectomy. He emphasized that preoperative weight loss and tight perioperative control of blood glucose levels may reduce the risk of SSI in laminectomy patients [9].

Hoelzer et al. (2017) in turn examined the risk of SSI in the spinal cord stimulator (SCS) implantation [10]. SCS is an a priori implantation - instrumentation procedure and implant is mandatory, not elective. Due to this, although in our department we did SCS in patients with DM, we did not include these patients in our analysis. Hoelzer et al. noted that the overall infection rate was 2.45% in SCS [10]. Diabetes, tobacco use, and obesity did not independently increase the rate of infection [10].

Le et al. (2011) emphasized that DM was becoming increasingly prevalent worldwide and additionally, there was an increasing number of patients receiving implantable devices such as glucose sensors and orthopedic implants [11]. According to Le et al. the number of diabetic patients receiving these devices would also increase [11].
noted that DM was generally indicated as a risk factor for the infection of a variety of implants such as prosthetic joints, implantable cardioverter defibrillators, penile implants, and urinary catheters [11]. Le et al. did not consider spine implants in his study, although his conclusions generally apply to all artificial implants (the mechanisms described by Le et al. could also apply to lumbar implants). According to Lee et al. implant infection rates in diabetic patients varied depending upon the implant and the microorganism, however, for example, diabetes was found to be a significant variable associated with a nearly 7.2% infection rate for implantable cardioverter defibrillators by the microorganism Candida albicans [11]. Lee et al. emphasized that understanding healing process is crucial to facilitating improved implant design. This is significant in spine implants technology [11].

Chen et al. (2009) noted that DM was a major risk factor for SSI and spinal surgeries were also associated with an increased risk of SSI [12]. To confirm previous reports Chen et al. evaluated the association of DM with spine infection in 195 patients who underwent elective posterior instrumented lumbar arthrodesis over a 5-year period: 30 with DM and 165 without [12]. It is exactly the idea and theme of our analysis and exactly the same issue. Chen et al. indicated other known risk factors for SSI in spinal surgery: age, gender, tobacco use, body mass index, American Society of Anesthesiologists (ASA) class, intraoperative antibiotic redosing, surgical time, bone allograft use, estimated blood loss (EBL), and drain use [12]. Chen et al. estimated that the adjusted relative risk of having DM for developing SSI was 4.10 (95% C.I. = 1.37–12.32). Other factors did not appear as risk factors for SSI. Thus Chen et al. confirmed DM was a risk factor for surgical site infections in spinal arthrodesis surgery [12]. And its results constituted level II of Evidence [12], (prognostic study – retrospective study).

Schimmel et al. (2010) noted that SSI were undesired and troublesome complications after spinal surgery [13]. According to his study infection rates ranged from 0.7 to 11.9%, depending on the diagnosis and the complexity of the procedure [13]. Schimmel et al. emphasized that the risk of SSI increased with the number of levels fused. In his analysis patients with DM had an almost six times higher risk and smokers had more than a two times higher risk for SSI [13]. The most common organism cultured was Staphylococcus aureus [13]. In Schimmel’s et al. study, all infected patients underwent at least one reoperation, including an open débridement and received appropriate antibiotics to treat the organism [13]. Patients who had had a previous spinal surgery are a high-risk group for infection compared with those that never had surgery [13]. Total costs associated with preventive measures are substantial and should be compensated by health care insurance companies by means of separate clinical pathways. Schimmel et al. emphasized that high - risk patients (including these wit DM with lumbar stenosis) should be informed about the increased risk of complications [13].

V. CONCLUSION

Although only a single reports suggest that spinal implants should be avoided in patients with DM, while the others give inconclusive results, the literature generally states that DM is a risk factor for SSI and implant rejection. This is identical with the neurosurgeons experience. Therefore, in patients with DM, the use of implants should be avoided, as long as they are elective.

Abbreviations

- DM - diabetes mellitus
- HbA1C - glycated hemoglobin
- JGP - homogeneous groups of patients (pol. jednorodne grupy pacjentów)
- ISS - interspinous spacer

Declarations

- Ethics approval and consent to participate: Was not required because the work concerned only retrospective analysis of medical documentation of patients without any participation or medical examination.
- Consent for publication: Written informed consent was not required.
- Availability of data and materials: All relevant data are within the paper.
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• Authors’ contributions:

ZS created the idea of this topic that seemed interesting in practice, the MSz as diabetology developed a theory about DM, EG-S reviewed the literature, ZS wrote the text, the MŚ checked in formal terms and approved. All authors read and approved the final manuscript.

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