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Original Article / Özgün Araştırma

# Investigation of the effects of abdominal aortic calcification on mortality in spinal surgery

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**Abstract**

**Objective:** The aim of this study was to show the effect of the presence of AAC on mortality after lumbar degenerative disc surgery and to determine whether it is a predictor of survival.

**Methods:** Between 2014 and 2016, abdominal aortic calcifications were recorded by grade in patients who underwent surgery for degenerative lumbar disc herniation and therefore underwent updated lumbar CT. In addition to the demographic data of these patients, ASA scores were also recorded and these scores were statistically compared.

**Results:** The age of the patients in the Advanced Calcification group was significantly ($p < 0.05$) higher than that in the Mild Calcification group. The ASA score in the Advanced Calcification group was significantly ($p < 0.05$) higher than the Mild Calcification group. . Ex rate in the Advanced Calcification group was significantly ($p < 0.05$) higher than the Mild Calcification group.

**Conclusion:** There is a strong correlation between the degree of abdominal aortic calcifications and patient survival. This relationship is thought to be an important guiding scoring for spinal surgeons in the preoperative preparation phase.

**Keywords:** Abdominal aortic calcification, survey, lumbar degenerative disc surgery, lumbar tomography, ASA score

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# Spinal cerrahide abdominalaortik kalsifikasyonun mortalite üzerine etkilerinin araştırılması

**Öz**

**Amaç:** Bu çalışmanın amacı lomberdejeneratif disk cerrahisi sonrası AAK varlığının mortalite üzerine etkisini göstermek ve sağkalım üzerinde bir belirleyici olup olmadığını saptamaktır.

**Yöntemler:** 2014-2016 yılları arasında dejeneratiflomber disk hernisi nedeniyle ameliyat edilen ve bu nedenle güncellenmiş lomber BT çekilen hastalarda abdominalaortik kalsifikasyonlar derecelendirilerek kaydedildi. Bu hastaların demografik verilerinin yanı sıra ASA skorları da kaydedildi ve bu skorlar istatistiksel olarak karşılaştırıldı.

**Sonuçlar:** İleri Kalsifikasyon grubundaki hastaların yaşı Hafif Kalsifikasyon grubundakilere göre anlamlı olarak ($p < 0.05$) daha yüksekti. İleri Kalsifikasyon grubunda ASA skoru Hafif Kalsifikasyon grubuna göre anlamlı olarak ($p < 0.05$) daha yüksekti. . İleri Kalsifikasyon grubunda Ex oranı Hafif Kalsifikasyon grubuna göre anlamlı olarak ($p < 0.05$) daha yüksekti.

**Sonuç:** Abdominalaortik kalsifikasyonların derecesi ile hasta sağkalımı arasında güçlü bir korelasyon vardır. Bu ilişkinin ameliyat öncesi hazırlık aşamasında spinal cerrahlar için önemli bir yol gösterici skorlama olacağı düşünülmektedir.

**Anahtar kelimeler:** Abdominalaortik kalsifikasyon, anket, lomberdejeneratif disk cerrahisi, lombertomografi, ASA skoru.

## INTRODUCTION

The abdominal aorta is one of the first arterial beds where atherosclerosis calcification is often seen before coronary artery calcification[1]. Unappreciated as a sign of structural vascular illness, abdominal aortic calcification can reveal patients at significantly higher risk of clinical cardiovascular events and with worse long-term prognoses[2].

Population-based study indicates that about one in three people between the ages of 45 and 54 and nine out of ten people over the age of 75 are affected by abdominal aortic calcification (AAC). In older persons with type 2 diabetes or renal disease who require dialysis, the prevalence of AAC ranges from 84% to 97%[3]. Apart from these diseases, peripheral vascular disease of AAC, there are studies showing its relationship with osteoporosis, rheumatoid arthritis, severe disc degeneration, smoking and Parkinson's disease[4].

Although almost all of these diseases are potentially associated with the poor outcome of spinal surgery, no spinal surgeon, except Sakaura et al., drew attention to the relationship between the presence of AAC and poor surgical outcome[5]. However, the presence of AAC can be easily detected in direct X-ray and CT obtained before surgery for lumbar region surgery.

Sakaura et al. reported that the presence of AAC is associated with poor surgical outcome in their study in patients who underwent laminoplasty for SCM, lumbar adjacent segment disease after PLIF, and fusion development after PLIF[6]. Operations related to lumbar degenerative disease aim to increase the quality of life rather than prolonging the life span[7]. Considering that more and more elderly people are exposed to spinal surgery, it becomes clear that an appropriate morbidity-mortality analysis should be performed in the conservative treatment-surgical treatment or minor surgery-major surgery dilemma.

American Society of Anesthesiologists (ASA) scores have been used for many years in surgical morbidity and mortality estimation[8]. In recent years, the Modified Frailty Index (mFI) has been preferred to determine how the

preoperative condition may affect postoperative outcomes and survival[9].

The primary objective of the current study was to determine if the presence of AAC, which has been linked to a higher risk of cardiovascular events, fatal cardiovascular events, and a poorer prognosis, may be a predictor of mortality and morbidity following lumbar degenerative disc surgery. The results were compared with the ASA scores.

## METHOD

The study was conducted retrospectively in 2023 on a group registered in a prospective study examining the effects of age and comorbid diseases on early complications in surgeries related to lumbar degenerative disease in the Department of Brain and Nerve Surgery between 2014 and 2016. The study complies with the Declaration of Helsinki and the ethical approval of the study was obtained from the Ethics Committee of Bağcılar Training and Research Hospital (approval number; 2023/03/05/015, dated; 24.03.2023).

Of the 278 prospectively enrolled patients, 33 patients who did not have lumbar CT within 3 months before or after surgery were excluded from the study. A total of 245 patients were included in the study. Preoperative ASA scores were obtained from prospective records, and ACA scores were measured retrospectively in February 2023 by 2 blind referees, one a radiologist and the other a spinal surgeon. Different results were re-evaluated by 2 referees and a joint decision was made. AAC scores were measured with a semi-quantitative system on a 5-point scale (Table-1, Figure-1). Demographic data and calcification degrees of the patients were recorded. (Table-2, Figure-2) All deaths and causes of death were obtained from the National Data System (Table-3).

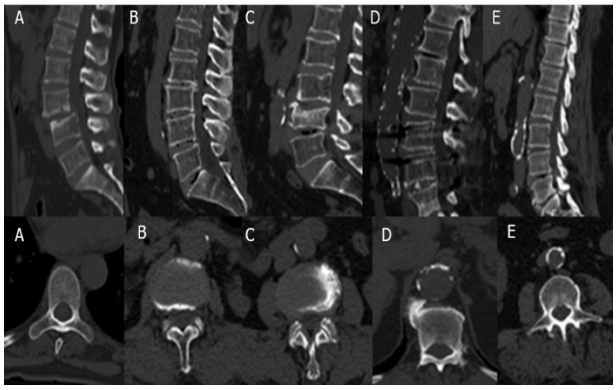


**Figure 1.** Sample pictures of abdominal aortic calcifications from our patients (A: grade 1; B: grade 2; C: grade 3; D grade 4; E grade 5)

**Table I:** Abdominal aortic calcification scoring system

| | |
|---|---|
| *1. degree* | No calcification |
| *2. degree* | Mild, contiguousandnon-peripheralcalcifications in multiplesegmentswith<50% involvement in a singlesegment |
| *3. degree* | >50% involvement in multiplesegmentsormoderatecircumferentialandnoncontiguouscalcifications in multiplesegments |
| *4. degree* | Isolated, concentric, circumferentialcalcificationswith>50% involvement in mostareas |
| *5. degree* | Diffuseperipheralcalcification |

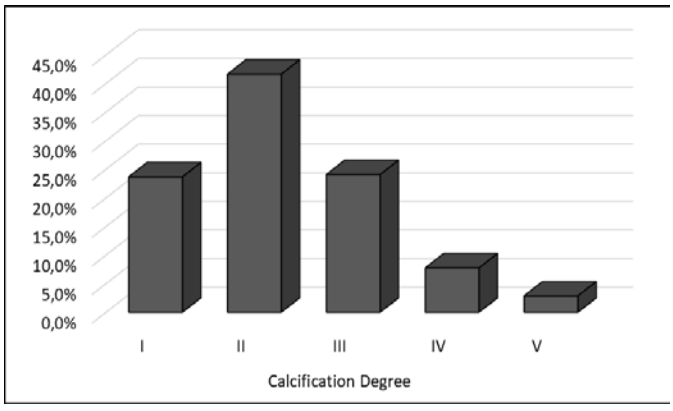


**Figure 2.** Schematic view of calcification degrees

**Table II:** Demographic data and Calcification degrees of the patients

| | | Min-Max | Median | Avr.±ss/n-% |
|---|---|---|---|---|
| Age | | 36.00 - 88.00 | 62.00 | 61.75 ± 8.82 |
| Gender | Female | | | 169 69.0% |
| | Male | | | 76 31.0% |
| ASA | I | | | 78 31.8% |
| | II | | | 132 53.9% |
| | III | | | 35 14.3% |
| Follow-up Time | | 1.00 - 107.00 | 83.00 | 81.94 ± 18.82 |
| Status | Ex | | | 35 14.3% |
| | Alive | | | 210 85.7% |
| ***Calcification*** | | | | |
| MildCalcification | | | | 160 65.3% |
| Advanced Calcification | | | | 85 34.7% |
| CalcificationDegree | I | | | 58 23.7% |
| | II | | | 102 41.6% |
| | III | | | 59 24.1% |
| | IV | | | 19 7.8% |
| | V | | | 7 2.9% |

**Table III:** General causes of death of patients

| | n | % |
|---|---|---|
| ***Cause of Death*** | | |
| LungOrigin | 19 | 26.7% |
| CardiovascularCauses | 19 | 26.7% |
| CausedbyInfection | 15 | 21.1% |
| KidneyFailure | 10 | 14% |
| Cancer | 6 | 8.4% |
| Accident | 2 | 2.8% |

## Statistical Approach

The median, lowest, highest, frequency, and ratio values were used to calculate the descriptive statistics for the data. The distribution of the variables was examined using the Kolmogorov-Smirnov test. employing the Mann-Whitney u test to analyze quantitative independent data. The Fischer Test was used to analyze qualitative independent data when the conditions for the chi-square test were not met. Cox-regression (univariate-multivariate) and Kaplan Meier were used for the survival analysis. For the analysis, SPSS 28.0 was utilized.

## RESULTS

The age difference between the patients in the Advanced Calcification group and the Mild Calcification group was statistically significant (p 0.05). Between the Mild Calcification and Advanced Calcification groups, there were no significant variations in the patient population's gender distribution (p > 0.05). In comparison to the Mild Calcification group, the Advanced Calcification group's ASA score was considerably (p 0.05) greater. The Follow-up Time value was substantially (p 0.05) lower in the Advanced Calcification group than it was in the Mild Calcification group. Ex rate was substantially (p 0.05) greater in the Advanced Calcification group than in the Mild Calcification group. (Figure-3) The Advanced Calcification (86.3 months) group's estimated survival time was considerably (p 0.05) shorter than that of the Mild Calcification group (10.4.7 months) (Table 4).

**Table IV:** Comparisons between groups

| | | MildCalcification | | | Advanced Calcification | | | p | |
|---|---|---|---|---|---|---|---|---|---|
| | | Avr.±ss/n-% | | Median | Avr.±ss/n-% | | Median | | |
| Age | | 58.69 | ± 8.00 | 58.00 | 67.49 | ± 7.31 | 67.00 | 0.000 | m |
| Gender | Female | 115 | 71.9% | | 54 | 63.5% | | 0.179 | $X^2$ |
| | Male | 45 | 28.1% | | 31 | 36.5% | | | |
| ASA | I | 67 | 41.9% | | 11 | 12.9% | | 0.000 | $X^2$ |
| | II | 82 | 51.3% | | 50 | 58.8% | | | |
| | III | 11 | 6.9% | | 24 | 28.2% | | | |
| Follow-up Time | | 85.99 | ± 13.25 | 84.00 | 74.32 | ± 24.63 | 80.00 | 0.000 | m |
| Status | Ex | 7 | 4.4% | | 28 | 32.9% | | 0.000 | $X^2$ |
| | Alive | 153 | 95.6% | | 57 | 67.1% | | | |
| CalcificationDegree | I | 58 | 36.3% | | 0 | 0.0% | | 0.000 | $X^2$ |
| | II | 102 | 63.8% | | 0 | 0.0% | | | |
| | III | 0 | 0.0% | | 59 | 69.4% | | | |
| | IV | 0 | 0.0% | | 19 | 22.4% | | | |
| | V | 0 | 0.0% | | 7 | 8.2% | | | |

*m Mann-whitney u test / $X^2$ Chi-Square test*

The Ex group's patients were significantly older than the live group's patients (p 0.05). The ratio of male patients in the Ex group was significantly higher than in the surviving group (p 0.05). In the Ex and Living groups, there was a statistically significant difference in ASA ratings (p 0.05). The rate of calcification in the Ex group was significantly (p 0.05) higher than that in the living group. The degree of calcification in the Ex group was significantly (p 0.05) higher than in the surviving group. In comparison to the living group, the Follow-up Time value was significantly (p 0.05) lower in the Ex group (Table 5).

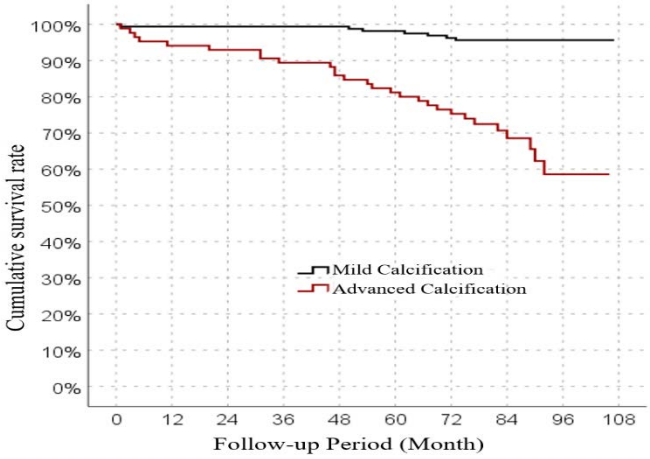


**Figure 3.** Relationship between calcification degree and survival

**Table V:** Effects of demographic data on survival

| | | EX | | | Alive | | | p | |
|---|---|---|---|---|---|---|---|---|---|
| | | Avr.±ss/n-% | | Median | Avr.±ss/n-% | | Median | | |
| Age | | 69.4 | ± 8.4 | 69.0 | 60.5 | ± 8.2 | 60.0 | ***0.000*** | m |
| Gender | Female | 16 | 45.7% | | 153 | 72.9% | | ***0.001*** | $X^2$ |
| | Male | 19 | 54.3% | | 57 | 27.1% | | | |
| ASA | I | 5 | 14.3% | | 73 | 34.8% | | ***0.000*** | $X^2$ |
| | II | 17 | 48.6% | | 115 | 54.8% | | | |
| | III | 13 | 37.1% | | 22 | 10.5% | | | |
| MildCalcification | | 7 | 20.0% | | 153 | 72.9% | | ***0.000*** | $X^2$ |
| Advanced Calcification | | 28 | 80.0% | | 57 | 27.1% | | | |
| CalcificationDegree | I | 2 | 5.7% | | 56 | 26.7% | | ***0.000*** | $X^2$ |
| | II | 5 | 14.3% | | 97 | 46.2% | | | |
| | III | 18 | 51.4% | | 41 | 19.5% | | | |
| | IV | 4 | 11.4% | | 15 | 7.1% | | | |
| | V | 6 | 17.1% | | 1 | 0.5% | | | |
| Follow-upV | | 51.4 | ± 27.6 | 55.0 | 87.0 | ± 10.3 | 84.5 | ***0.000*** | m |

*m Mann-whitney u test / $X^2$ Chi-Square test*

## DISCUSSION

Abdominal aortic calcifications (AACs) have been shown to be a marker for cardiovascular disease because of their strong correlation with widespread atherosclerosis, cardiovascular events, and a significant risk of osteoporosis and fracture. When the arteries harden and calcify, a condition known as arterial calcification develops[10]. Intimal calcifications have been found to be more common and pervasive in the distal abdominal aorta than in the descending and aortic arches, and less common in the ascending aorta. In the same experiment, it was shown that the distal abdominal aorta was the body's first arterial site to calcify[11].

Aortic calcifications that may be seen on tomography are located in the intimal layer of the abdominal aortic wall. Studies have shown that CT is an effective method for identifying these calcifications and their annular development[12].

According to a study by Jia J et al., a higher healthy eating index may be helpful for adults in reducing vascular calcification and CVD since it is linked to a lower AAC score and a decreased likelihood of developing AAC[13].

Patients with COPD have a very high prevalence of AAC and its expanded form. AAC severity in women with COPD can be used as a sign of musculoskeletal fragility since it is easily quantified by standard spine radiography[14].

In a study by Efe D. et al. abdominal aortic calcification was found to be more common in patients with nephrolithiasis[15].

According to a cross-sectional study by Qin Z. et al., higher visceral adiposity index levels are linked to higher AAC scores and a greater chance of severe AAC[16].

In a study, it was determined that patients with a high abdominal aortic calcification score had a significantly increased all-cause and cardiovascular mortality[17].

In our study, we found that the degree of aortic calcifications increased in parallel with age, which was consistent with the literature[18].

In our study, no gender difference was observed between the calcification groups. The absence of gender differences in the presence and degree of calcification has been demonstrated in cross-sectional studies with large participation[19].

We observed a significant correlation between ASA score and calcification degree in our advanced calcification groups. Considering that one of the most common comorbidities in chronic patients such as chronic kidney disease is vascular calcifications, which are pathological mineral deposition in the vascular system, predominantly in the medial layer of the vessel wall, and cause significant morbidity and mortality, this is quite expected[20].

In our study, it was observed that the mortality rate in advanced calcification groups was significantly higher than in the mild calcification group. (Figure-3) In a study with large participation, a strong correlation was observed between abdominal aortic calcification and mortality rates. This and similar results in the literature are consistent with our study[21].

An investigation revealed that severe calcification in the abdominal aorta was correlated with a significant upsurge in the 90-day mortality rate among sepsis patients who were hospitalized in the ICU. Additionally, when analyzing subcategories based on age, the study discovered that individuals under 65 years old with severe calcification also experienced a notable rise in 90-day mortality[22].

Atherosclerosis represents a persistent condition impacting arteries characterized by elasticity and a combination of elasticity with muscular properties. It encompasses the deposition of atherogenic lipoproteins within the arterial wall, provoking a reaction from both vascular wall cells and mononuclear cells

originating in the bloodstream. This reaction triggers an ongoing inflammatory process, establishing a self-perpetuating cycle[23].

Consequently, a state marked by heightened inflammation and a tendency for blood clot formation becomes inherent to atherosclerosis, augmenting susceptibility to serious infections. Furthermore, this condition amplifies the incidence of heart attacks, strokes, and complications associated with venous thromboembolism[23].

We saw that the etiology and prognosis of vascular pathologies of abdominal aortic calcification were mentioned in the literature, but there was no study evaluating the effect of spinal surgery on mortality before spinal surgery. We planned to conduct such a study both to fill this gap in the literature and to emphasize the importance of pre-op evaluation of this vascular pathology, which is frequently observed in the population, which can predict prognosis similar to the ASA score.

We believe that this study should be evaluated as an important predictive guide for spinal surgeons in the estimation of mortality in patients with abdominal aortic calcification. We think that a new scoring system similar to the ASA score will be valuable in predicting prognosis during spinal surgery preparation and will create a different perspective in the literature.

The factors limiting our study is the fact that the patient group we included in the study was relatively small in numbers. There is no doubt that it will be a pioneering study in the following years with larger participants.

## CONCLUSION

Abdominal aortic calcification is a vascular pathological clinical condition that is thought to have a definite effect on mortality, as shown in many studies. We are of the opinion that this clinical condition, which has been associated with different clinical conditions in many studies and affects the prognosis negatively with the increase in the degree of calcification, is useful in spinal surgery as a scoring similar to the ASA score. We think that this study will contribute to scientific developments with a larger participant group and a more evidence-based data management.

**Ethics Committee Approval:** This retrospective studystudy was approved by the ethics committee of Bağcılar Training and Research Hospital (Project Number: 2022/01).

**Conflict of Interest:** The authors declared no conflicts of interest.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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