Changes in creatine kinase serum in patient after total hip arthroplasty

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ABSTRACT

**Background:** Some studies reported that measuring serum creatine kinase (CK) level is an objective method with which to determine the relative invasiveness of surgery. The purpose of this study was to evaluate the change in post-operative serum CK levels as a measure of whether the direct anterior approach (DAA) is less invasive than the posterior approach (PA) regarding postoperative rehabilitation.

**Methods:** This study design was a descriptive research with a qualitative approach, systematic literature review study. ResearchGate, Google Scholar and ScienceDirect searches reviewed changes in serum creatine kinase in patients after total hip arthroplasty. A total of 5 studies conducted between 2019-2023 were included in this review to present a literature review regarding changes in serum creatine kinase in patients after total hip arthroplasty.

**Results:** We analyzed biochemical markers of muscle damage markers provides an unbiased way of determining the immediate effects of surgical intervention in patients treated with total hip arthroplasty.

**Conclusion:** The objective measurement of muscle damage markers provides an unbiased way of determining the immediate effects of surgical intervention in patients treated with total hip arthroplasty.

**Key Words:** creatine kinase, post-operative, total hip arthroplasty.

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INTRODUCTION

Total hip arthroplasty (THA) is one of the most cost-effective and consistently successful surgeries performed in orthopaedics. Beside the development of implants material and surgical instruments for better mobility and longevity of artificial hip joint, the minimally invasive total hip arthroplasty has also been improved. Minimally invasive total hip arthroplasty requires the proper instrument, appropriate surgery approach with an experienced surgeon. Minimally invasive total hip arthroplasty is to cause less trauma to soft tissue and is not the same as smaller incision. The smaller incision is one of the criteria in minimally invasive total hip replacement but with smaller incision may cause poor exposure, challenging to manipulate instrument and implants, damage surrounding soft tissue such as muscle, nerve, artery and poor implant position. What one of the challenge surgeons have to face is to evaluate the efficiency and result of minimally invasive total hip replacement.1,2 If only based on pain and range of motion before and after surgery, the study is not accurate and objectively because pain is somewhat subjectively and affected by pain medicine and patient's pain tolerance. Hip range of motion is also affected by hip pathology, hip contracture condition before surgery and challenging to address the relationship between soft tissue trauma after surgery with the range of motion. A smaller incision but causes more trauma to soft tissue is not less invasive than a bigger incision with less trauma. Using laboratory data in serum to measure muscle damage provide an objective method to evaluate the invasiveness between different surgical techniques and approaches.3

Creatine phosphokinase (CPK) also known as creatine kinase is an enzyme which catalyzes the conversion of creatine and utilizes adenosine triphosphate (ATP) to create phosphocreatine (PCr) and adenosine diphosphate (ADP). CPK plays a vital role in monitoring energy to different cells, especially muscle cells. CPK is an enzyme found primarily in cardiac muscle, skeletal muscle, and brain tissue. CPK is classified using chromatography into three distinctive isoenzymes: CPK BB (brain) is expressed in the brain cell and smooth muscle in lungs; CPK MB (cardiac muscle) is expressed in cardiac muscle; CPK MM (skeletal muscle) is expressed in skeletal muscle. In normal condition, human serum contains mostly CPK MM. CPK MB is 5% of total CPK, and CPK BB is insignificant. CPK level test is a valuable test in diagnostic skeletal muscle...
pathology. Therefore because of that, this study is to evaluate CPK level in non-cemented total hip replacement.

This research sets two main objectives. Firstly, it aims to provide a comprehensive review of research on changes in serum creatine kinase in patients after total hip arthroplasty using the ResearchGate, Google Scholar and ScienceDirect databases. Secondly, based on the analysis conducted on available publications, this research will identify research gaps and provide directions for future research.

METHODS

The research design is a descriptive research method with a qualitative approach to literature study or literature review using the internet and manual search. Data was collected using databases and search engines ResearchGate, Google Scholar and ScienceDirect. The search was carried out using the keywords “changes in serum creatine kinase in patients after total hip arthroplasty”.

The inclusion criteria for this research are that the articles used as literature are research articles, both original articles and studies/reviews. Articles or literature discussing changes in serum creatine kinase in patients after total hip arthroplasty were published from 2019-2023. Researchers found articles that matched these keywords with details from ResearchGate (n=29,300), Google Scholar (n=12,400) and ScienceDirect (n=1,190) so that n=42,890. The search results that were obtained were then checked for duplication using Mendeley and the same articles were found, so there were articles that were excluded or duplicated (n=7,890). Researchers carried out screening based on the title (n=810), then obtained abstracts (n=105) then a complete copy was taken and assessed for suitability (n=10) then screened based on inclusion and exclusion criteria on the entire text (full text) so that A total of (n=10) were obtained which could be used in a systematic literature review. The results of article selection can be depicted in the Preferred Reporting, Items for Systematic Reviews and Meta Analysis (PRISMA) diagram flow below.

RESULTS

The study results showed that 5 articles met the criteria based on the literature reviews topic. The results of study characteristics from 3 databases (ResearchGate, Google Scholar and ScienceDirect) are depicted in Table 1.

DISCUSSION

Creatine kinase (CK) is an enzyme that’s found in your skeletal muscle, heart muscle and brain. When any of these tissues are damaged, they leak creatine kinase into your bloodstream. Elevated CK levels may indicate muscle injury or disease. Creatine kinase consists of two subunits, namely B (brain) and M (muscle), each subunit has a molecule weighing 43,000 dalton. The combination of these two subunits will only produce three creatine kinase isoenzymes, namely CK-BB (CK-1), CK-MB (CK-2), and CK-MM (CK-3). CK-BB can be mainly found in the kidney and brain while CK-MM is mostly found in skeletal muscle. CK-MM is found in high concentrations in skeletal and cardiac muscle. CK-MB has high concentrations in heart muscle, but CK-MB is also found in small amounts in the lungs, small intestine, uterus, prostate and healthy skeletal muscle. CK-MM is most abundant in skeletal muscle and CKMB is most abundant in cardiac muscle.
### Table 1. References articles summary

<table>
<thead>
<tr>
<th>No.</th>
<th>Authors</th>
<th>Title</th>
<th>Methods</th>
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<tr>
<td>1.</td>
<td>Luca De Berardinis, Marco Senarighi, Luca Farinelli, Fjorela Qordja, Alberto Gallo, Marco Spezia and Antonio Pompilio Gigante (2023)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>In primary total hip arthroplasty, the direct anterior approach leads to higher levels of creatine kinase and lower levels of C-reactive protein compared to the posterolateral approach: a propensity score matching analysis of short-term follow-up data</td>
<td>Literature review</td>
<td>CK was significantly higher (p &lt; 0.001) in the DAA than in the PLA group on postoperative day (POD) 2, 5 and 10. The POD2, POD5 and POD10 CK/preoperative CK ratio was 12.9, 5.0 and 0.8 in DAA and 8.8, 3.3 and 0.6 in PLA (p = 0.017, p = 0.012 and p = 0.025, respectively). The POD2, POD5 and POD10 CRP/preoperative CRP ratio was 95.1, 65.6 and 22.8 in PLA and 34.7, 23.3 and 8.9 in DAA (p &lt; 0.001, p = 0.002 and p &lt; 0.001, respectively). Conclusion PSM analysis of early postoperative CK and CRP values demonstrated that the DAA should be considered as a less stressful approach, not as a muscle-sparing or a minimally invasive THA approach.</td>
<td>Science Direct</td>
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<td>2.</td>
<td>Nikolai Ramadonov, Polina Marinova-Kichikova, Robert Hable, Dobromir Dimitrov and Roland Becker (2023)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Comparison of Postoperative Serum Biomarkers after Total Hip Arthroplasty through Minimally Invasive versus Conventional Approaches: A Systematic Review and Meta-Analysis of Randomized Controlled Trials</td>
<td>Literature review</td>
<td>Our meta-analysis indicates that there was no significant overall difference between MI THA and CA THA in terms of postoperative serum biomarkers (CK, CRP, and Hb). We found a slight advantage of MI THA in CRP values. MI THA had a 16 mg/L lower CRP value 3 days postoperatively than CA THA. MI THA had a 3 mg/L lower CRP value for 4 days postoperatively than CA THA. However, these findings do not provide sufficient evidence to recommend changing the surgical approach from CA THA to MI THA, since the differences between the examined approaches did not seem to reach MCID.</td>
<td>Science Direct</td>
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<td>3.</td>
<td>Weikun Meng, Liang Gao, Zhong Huang, Haoyang Wang, Duan Wang, Zeyu Luo, Yang Bai, Guanglin Wang, Zongke Zhou (2021)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Supercapsular percutaneously-assisted total hip (SuperPath) versus mini-incision posterolateral total hip arthroplasty for hip osteoarthritis: a prospective randomized controlled trial</td>
<td>Literature review</td>
<td>Compared with the PLA group, the SuperPath group yielded a significantly shorter incision length (7.83 vs. 12.45 cm, P&lt;0.001), longer operative time (102.72 vs. 66.22 min, P&lt;0.001), more blood loss (1,007.38 vs. 844.55 mL, P=0.005), and more soft tissue damage (creatine kinase: 1,056.05 vs. 821.50 U/L, P=0.006) on postoperative day 3. The SuperPath group also showed deficient acetabular cup positioning (abduction angle: 36.94° vs. 42.66°, P=0.004) and a greater decrease in ROM (flexion: 107.66° vs. 114.44°, P=0.004; 109.83° vs. 116.11°, P=0.002; 111.66° vs. 118.88°, P=0.001) on postoperative days 1, 3, and 14, as well as severe early-term pain symptoms (painVAS on postoperative day 3: 7.05 vs. 6.55, P=0.041). However, the LOS, C-reactive protein levels, erythrocyte sedimentation rate (within 2 weeks postoperatively), and HHS were comparable between the groups during the 12 months postoperatively. SuperPath may be a promising, minimally invasive technique for the treatment of OA in the future. Further investigation is necessary to evidence the possible superiority of SuperPath over other conventional mini-incision THA approaches.</td>
<td>Research Gate</td>
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<td>4.</td>
<td>Bronisława Skrzep-Poloczek, Jakub Poloczek, Elżbieta Chelmekowa, Wojciech Kazura, Agnieszka Dulska, Maciej Izdik, Jerzy Jochem, and Dominika Styrar (2020)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>General, 21-Day Postoperative Rehabilitation Program Has Beneficial Effect on Oxidative Stress Markers in Patients after Total Hip or Knee Replacement</td>
<td>Literature review</td>
<td>We can conclude that the 21-day postoperative general rehabilitation program has a significant impact on balancing oxidative processes and significant reduction of oxidative stress markers in patients with hip or knee replacement. Individually tailored, systematic physical effort is a crucial element of the postoperative protocol, which helps patients to recover effectively after the surgery by improving the redox balance.</td>
<td>Google Scholar</td>
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<td>5.</td>
<td>Hisahiro Tonotsuka, Hajime sugiyama, Daisuke Tanaka, Tatsuto Ito, Ayano Amagami, and Keishi Marumo (2019)&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Postoperative creatine kinase elevation following hip arthroscopy and associated risk factors</td>
<td>Literature review</td>
<td>Mean CK was 104.7 ± 68.7 IU/L preoperatively and 839.2 ± 2214.0, 523.9 ± 1449.4, 186.0 ± 690.7, and 122.0 ± 307.1 IU/L on postoperative days 1 and 3 and at postoperative weeks 1 and 2, respectively. CK was significantly higher on postoperative days 1 and 3 than before surgery. In total, 11 patients (9.0%), including 8 males (16.0%) and 3 females (4.2%), had CK &gt; 10 ULN. Younger age and longer duration of traction are independent risk factors for CK &gt; 10 ULN. After hip arthroscopy, CK levels should be monitored, especially in young patients and cases of prolonged duration of traction during surgery.</td>
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The physiological role of creatine kinase is to maintain large amounts of phosphorylated creatine energy, which is used to restore the amount of ATP that has been used during muscle contraction. In muscle tissue that requires high energy intake (ATP), for example striated muscle, this enzyme plays a role in catalyzing the production of ATP (energy). Normal CK levels range between 20-200U/L and an increase in CK is an indication of muscle damage which is characterized by the possibility of muscle injury or is caused by certain medications such as statin drugs. Meanwhile, an increase in total creatine kinase is not specific to the heart and can be found in patients with skeletal muscle injuries. Clinically, a creatine kinase test is performed to look for indications of heart attack, rhabdomyolysis, muscular dystrophy and kidney failure.

Total hip arthroplasty has been indicated as the surgical intervention with greatest improvement in pain and physical function. However, some patients continue to experience hip pain after elective surgery. There are some prognostic factors that negatively affect treatment effectiveness and the patient outcome. The “hip region” constitutes the groin, buttock, upper lateral thigh, greater trochanteric area, and the iliac crest. Pain originating from various sources and not directly linked to prosthesis may be perceived here and includes the lumbosacral spine, referred pain from abdominal organs and soft tissue sources such as trochanteric bursitis, tendinitis, hip abductor dysfunction, and inguinal hernia. An accurate assessment of the pain cause is extremely difficult to construct and a complete differential diagnosis is fundamental. All the possible causes of hip pain were assessed afterwards and divided depending on the presence or absence of radiographic signs.

Total hip arthroplasty is one of the most clinically successful and cost-effective interventions in health care, with excellent long-term results in terms of reducing pain and improving function and quality of life in patients with debilitating hip disease. Self-reported patient satisfaction has been reported to be closer to 90%. Many authors reported on successfully relieved pain after THA also in cases where patients’ preoperative functional status was poor. Physical function improvement is long lasting over 25 years and is not affected by mild pain. However, despite remarkable developments in surgical technique and implant design, some patients continue to experience distressing pain after elective surgery. Results from a Danish nationwide study found that 12.1% of patients 12-18 months after hip arthroplasty were significantly impaired in their daily activities by chronic pain. The occurrence of pain following a technically satisfactory arthroplasty is of concern for both the orthopaedics surgeon and the patient. It’s one of the most difficult challenges for the surgeon to evaluate and to treat.

The difficulties in managing pain is due to the heterogeneous nature of the disease. Pain related to the surgery itself can be associated with the implant, bone alterations and soft tissue or nerve injuries. The situation is complicated when history, clinical examination, and plain radiography fail to locate the exact origin of hip pain. In a few cases patients were revised without having found the cause of pain. In the total 299,368 primary total hip arthroplasty reported in the Swedish Hip Register that were performed from 1979 to 2008, the 0,03% was revised for pain as a single cause representing the 0,4% of all the reasons for revision in the 24,199 first revision.

CONCLUSION

In patients undergoing total hip arthroplasty, the objective measurement of muscle injury marker offers an impartial means of assessing the immediate impact of surgical intervention.

CONFLICT OF INTEREST

The authors affirmed that there were no conflicts of interest in this study.

FUNDING

The author was responsible for the funding without obtaining financial support.

REFERENCES

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