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Changes of the serum creatine phosphokinase in total hip arthroplasty in Vietnamese patients

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ABSTRACT

Background: We analyzed biochemical markers of muscle damage in patients treated with total hip arthroplasty with minimally invasive and standard posterolateral approach to providing objective evidence of the local soft-tissue injury at the time of arthroplasty.

Methods: Sixty-one patients in group one treated with minimally invasive total hip arthroplasty through an approach less 9 cm length and fifty-three patients in group two treated with the same procedure through an approach more than 9 cm length. Serum creatine phosphokinase (CPK) levels were measured preoperatively and on postoperative days 1, day 2 and 5.

Results: The levels of the markers of muscle damage were increased in both group. The rise in the CPK level on postoperative day 1 in both group was 2.5–3 times higher than preoperative CPK and were slightly decreased on the next few days. There were no significant differences between the two cohorts of changes of CPK level.

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

1. Introduction

Total hip arthroplasty is a standard procedure in the world and Vietnam. Beside the development of implants material and surgical instrument for better mobility and longevity of artificial hip joint, the minimally invasive total hip arthroplasty 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. 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 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 cause 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. 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 cell. CPK is an enzyme found primely in cardiac muscle, skeletal muscle, and brain tissue. CPK is classified using chromatography into three distinctive isoenzymes: CPK BB is expressed in the brain cell and smooth muscle in lungs;

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CPK MB is expressed in cardiac muscle; CPK MM 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. So because of that, this study is to evaluate CPK level in non-cemented total hip replacement.

2. Patients and methods

1 **Patients**: 114 patients with non-cemented total hip arthroplasty in Bach Mai Hospital from July 2014 to July 2016.
   i **Patient selected criteria**: primarily non-cemented total hip arthroplasty with randomly selected either minimally invasive approach or standard posterolateral approach, patient's information and laboratory test as required for the study.
   ii **Patient excluded criteria**: not obtain full patient's information, laboratory test, cemented total hip replacement or hybrid total hip replacement, hip hemiarthroplasty. Patient with history of prior injury or surgery in the hip, dermatomyositis, renal failure, heart failure, patient on medicine affecting skeletal muscle such as anticoagulant, muscle relaxation, diuretic. The patient does not agree to involve in the study.

2 Methods:
   i **Cross sectional study**
   - The patient selected with total hip arthroplasty indication and meet the criteria.
   - Pre-op laboratory test including CPK level.
   - Non-cemented total hip arthroplasty with one surgeon using a minimally invasive approach or standard posterolateral approach.

   ii **Surgery technique:**
   - All patients are going on spinal anesthesia, lateral decubitus on the contralateral hip. The posterolateral hip approach is chosen.
   - With a minimally invasive incision less than 9 cm, we split through the fiber of gluteus maximus muscle, take down the insertion of the external rotators: piriformis, gemellus superior and inferior, obturator internus.
   - With a standard posterolateral longer than 9 cm, we take down a superior portion of the quadratus insertion. Open the hip capsule, dislocate the hip posteriorly.
   - Cut the femoral neck as pre-op templating, reaming the acetabulum and place the trial component. We are then broaching the femoral canal to the proper size. Reduce the hip joint using trial components and check for stability, the range of motion. Replace the hip with implants size accordingly. Restore capsule and external rotators attachment. We do use drainage and close the wound in standard fashion.
   - Patients are taken post-op, first day and fifth-day laboratory test including complete blood count, prothrombin time, partial thromboplastin time, INR, renal and liver function test, CPK level tests.

3. Results

- A total of 114 patients met the study's criteria, 94 male (81.6%) and 21 female (18.4%).
- Patients' average age was 52.72 ± 14.44 (range, 18–82)
- The minimally invasive approach used in 61 patients (53.51%), the standard posterolateral approach used in 53 patients (46.49%).

Table 1
The correlation between incision length and BMI.

Incision length	BMI			Total
	N			
	<18.5	18.5–22.9	>23	
≤ 9 cm	27	29	5	61
> 9 cm	5	27	21	53
Total	32	56	26	114

Comment: Different incision length between BMI groups. Higher BMI tends to have longer incision ($p < 0.05$).

- The average length of the minimally invasive incision is 8.39 ± 0.56 cm (range, 7–9 cm). The average length of standard posterolateral approach is 12.09 ± 2.26 cm (range, 10–18 cm).
- The average BMI is 20.64 ± 3.31 (range, 13.6–33.5) separate into 3 BMI groups:
  - Group 1: BMI < 18.5 with 32 patients
  - Group 2: BMI from 18.5 to 22.9 with 56 patients
  - Group 3: BMI > 23 with 26 patients

4. Discussion

Minimally invasive total hip arthroplasty is may be advantageous for both patient and surgeon. Smaller incision and less invasive dissection could lead to less post-op pain and faster recovery. Surgeons who are encouraging minimally invasive suggest that hip replacement may be done without cutting through any muscles or ligaments. Various cadaveric studies carefully verify this idea, and it showed total hip arthroplasty may not always be done without injuring soft tissues.[1]

Mardones R. et al. study was to quantify the extent and the location of damage to the abductor and external rotator muscles and tendons after two-incision and mini-posterior total hip arthroplasty. Ten cadavers (20 hips) were studied. In each cadaver, one hip randomly was assigned to the two-incision group, and the contralateral hip was assigned to the mini-posterior group. After inserting the total hip arthroplasty components, the muscle damage was assessed using a technique described previously. Damage to the muscle of the gluteus medius and gluteus minimus was substantially more significant with the two-incision technique than with the mini-posterior technique. Every two-incision total hip replacement caused measurable damage to the abductors, the external rotators, or both. Every mini-posterior hip replacement caused the external rotators to detach during the exposure and had additional measurable damage to the abductor muscles and tendon. The author suggested that a two-incision total hip arthroplasty cannot be done without cutting or damaging the gluteus medius or gluteus minimus muscle or external rotators.[2]

In non-cement hip arthroplasty, we split the maximus gluteus and use a Charnley extractor, and the external rotators are partially cut to expose the capsule. The minimus and medius gluteus could be extracted without cutting, but prolong surgery is still damaging the tissue because the CPK level increased 2.5 to 3 times post-op (Table 2). Apple FS. et al., the study was assessed in 35 women and 34 men runners after a 42.2-km race using a method developed for estimation of myocardial infarct size. Results indicate that greater skeletal muscle damage occurred in men vs. women runners after a marathon.[3] In the study of Larsson K. et al., the CPK activity of the serum of 33 male and 24 female patients with tibial shaft fractures has been assessed. In 40 of the 57 patients, the CPK level surpassed the maximal standard limit of 1.7/1. Patients with fractures due to direct force had significantly higher levels than

Table 2
The correlation between CPK level and incision length.

Incision length	CPK level			
	Pre-op	Post-op		
		Day 1	Day 2	Day 5
≤ 9 cm	96.48 ± 69.27	231.46 ± 153.24	202.52 ± 147.26	182.94 ± 143.53
> 9 cm	91.92 ± 66.44	281.42 ± 202.68	249.36 ± 191.11	238.33 ± 201.21

Comment: The CPK level increase 2.5 to 3 times postoperatively and gradually decreased in the following days. No differences in CPK level between the longer and shorter incision ($p > 0.05$).

Table 3
The correlation between CPK level and gender.

Gender	CPK level			
	Pre-op	Post-op		
		Day 1	Day 2	Day 5
Male	98.95 ± 69.16	265.82 ± 189.81	235.07 ± 180.14	218.07 ± 184.93
Female	73.52 ± 66.44	205.38 ± 109.27	176.62 ± 104.50	159.70 ± 90.69

Comment: No differences in CPK level between gender group ($p > 0.05$).

Table 4
The correlation between CPK level and BMI.

BMI	CPK level			
	Pre-op	Post-op		
		Day 1	Day 2	Day 5
< 18.5	93.09 ± 71.17	225.84 ± 144.67	197.28 ± 137.80	177.67 ± 136.78
18.5–22.9	95.75 ± 68.29	245.79 ± 154.63	215.79 ± 147.72	188.38 ± 133.24
> 23	92.50 ± 63.74	309.35 ± 248.46	302.19 ± 267.37	275.89 ± 234.69

Comment: No differences in CPK level between BMI groups ($p > 0.05$).

those with fractures due to indirect force. When the fracture was displaced, the CPK level was more often abnormal than when there was no displacement. Patients with extensive swelling of the injured leg had significantly higher levels than patients with minor or no swelling.[4]

In our study, CPK level increased in male and female group post-op and gradually decreased in the following post-op days and no difference in both groups (Table 3). The same result in different BMI groups, this might be the same in soft tissue damaged with the same muscle mass (Table 4). Gender and BMI are not representing the muscle mass, and soft tissue damage, and only reflect the over-weight or under-weight condition of the patients. However, BMI might be the critical factor affecting the incision length, and the higher BMI might lead to longer incision for adequate exposure for proper reaming and place hip components (Table 1).

The smaller incision might affect the vision, difficult for placing instrument and hip components and may require more extended extractor and causing soft tissue damaged. Moreover, prolong surgery time might lead to ischemia of the soft tissue under tension, and higher CPK level as a result. Meneghini RM. et al., compared muscle damage during minimally invasive total hip arthroplasty: Smith-Petersen versus posterior approach. The study was performed in six human cadavers (12 hips), one hip was assigned to the Smith-Petersen approach and the contralateral hip to the posterior approach. Muscle damage was graded with a technique of visual inspection to calculate a proportion of surface area damage. Less damage occurred in the gluteus minimus muscles and minimus tendon with the Smith-Petersen approach. A mean of 8% of the minimus muscle was damaged via the Smith-Petersen approach, compared to 18% via the posterior approach. The tensor fascia lata muscle was damaged (mean of 31%), as well as the head of the rectus femoris (mean 12%) during the Smith-Petersen approach. The piriformis or conjoined tendon was transected in 50% of the anterior approaches to mobilize the femur. The different hip approach leads to different muscle damaged.[5]

In our study, we used mini posterolateral and standard posterolateral approach with a similar technique. The CPK levels increased in both groups with no difference (Table 2). So, through a smaller incision, we could still avoid muscle damaged, provided a faster recovery and better cosmetic, less pain. Suzuki K. et al., study with 94 patients (8 male and 86 female), a total of 100 total hip arthroplasty procedures separate into two groups: minimally invasive and standard incision. The CPK level is measured pre-op and day one post-op and showed 4.7 times increased in the standard incision, 3.6 times increased in the minimally invasive incision, but not statistically different between groups. Our study result has a comparable outcome as Suzuki K et al.[6]

5. Conclusions

CPK level is a practical and objective test to evaluate the soft tissue damage in total hip arthroplasty. We believe this test is an important step in evaluating different total hip arthroplasty technique in term of less invasive. More study should be done to further develop technique and surgical instrument.

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