MULTIPLE DAMAGE OF THE TIBIAL POLYETHYLENE INSERT IN KNEE JOINT PROSTHESIS (CAN EXCELLENT POSTOPERATIVE OUTCOME BE THE CAUSE OF THE TIBIAL INSERT FRACTURE?)
Case report and review

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Abstract
Despite improvements in prosthesis technology and use of high-quality materials in recent years, the number of revisions related to implant failures (4.7%) remains high. Several phenomena were reported in literature as reasons for dislocation and fracture of tibial insert in mobile bearing prosthesis: incorrect positioning of components, discrepancy of extension and flexion balancing or ligament weakness. However, in our cases neither of these causes were observed. The authors consider that bio-physiological and biomechanical aspects of total knee arthroplasty and knee joint prosthesis should be thoroughly studied and implemented into the clinical practice. In the described cases, multiple damage of the insert due to flexion instability and “twist-hyperflexion” in overweight patients is perceived as the reason for failures.

Key words: total knee arthroplasty, mobile-bearing, floating platform prosthesis, tibial insert failure.

Introduction
The rapid proliferation of total knee arthroplasty naturally increases the number of complications and revision cases [2, 4]. Despite improvements in prosthesis technology and the use of high-quality materials, the number of revisions related to implant failures (4.7%) remains high [1, 3] throughout the recent years. Reports have been made citing deformation, early wear, delamination, decomposition of the backside or border part of the polyethylene insert and damage of the tibial post in knee joint prosthesis [9, 11, 19]. However, multiple complicated failures with complete fracture of posterior flexion part of the tibial insert were very rare. In our practice we observed only two such cases with interesting arthroplasty history resulting in failure.

Case 1
A 65 year old woman (weight = 58 kg, height = 1.43 m, body mass index = 28.4) sought help from our hospital regarding pain in the left knee joint persisting for the past six months. Eleven years ago she underwent a high tibial osteotomy on the right knee due to medial unicompartmental osteoarthritis (OA); in five years after that total knee arthroplasty was performed on her left knee using a floating platform mobile-bearing TKA with a 10 mm polyethylene insert (e.motion® FP, B. Braun-Aesculap). However, five years after the surgery she felt instability and pain in her left knee when standing up from a seated position. Physical examination of the knee showed the range of motion from 20° to 110°; there was a clicking sound and pain in full flexion. Further tests showed medial joint line tenderness (-), valgus/varus stress test (-/+), locking/crepitus (-/+), CRP value of 0.81. She felt the first crunch in the knee while she wanted to raise her granddaughter on her back when sitting with full flexed knee.

Through the previous skin incision a medial parapatellar arthrotomy was performed to remove damaged insert. Intraoperative findings showed that the lateral posterior flexion part of the tibial polyethylene insert was fractured and displaced to the rear part of the knee.

Additionally, authors observed destruction of the posterior edge of the broken fragment and posteromedial part of the upper surface of the tibial insert known as “melting” (Fig. 2). After irrigation of the knee joint and surrounding soft tissues with aseptic solution the tibial insert was replaced. Postoperatively the range of motion was observed

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from 0° to 130° of flexion. The patient was discharged four days after surgery following medical treatment and physiotherapy.

She felt a sudden onset, sharp pain in her right knee while walking downstairs. No swelling or knee motion limitation was reported at the time. The range of motion during right knee examination was observed from 0° to 130°; there was clicking sound and pain during full flexion. Further tests showed patellar tendon tenderness (+), valgus/varus stress test (+/+), locking/crepitus (+/+), CRP value of 0.83. Radiographs showed reduction in the distance between the femoral and tibial components (Figure 3). The patient associates pain with a daily routine sitting position while working on a kale farm, pain onset she noticed a month ago when trying to lift heavy goods from a seated position with flexed knee.

Case 2
A 59 year old woman (body mass index = 26.7) complained of the right knee pain during previous two weeks. Eight years ago the patient was arthroscopically diagnosed with a Baker’s cyst, and subsequently underwent an open cystectomy in a private hospital. Three years ago she underwent a computer navigated TKA (using a floating platform mobile bearing prosthesis with a 10 mm thick polyethylene bearing (e.motion® FP, B. Braun-Aesculap) in our hospital due to OA in the right knee.

Revision TKA was performed using a standard mid-line incision and medial parapatellar arthrotomy. Intraoperative findings showed that the lateral posterior flexion part of the tibial polyethylene insert was fractured and a broken fragment was displaced towards the anterior part of the knee. In addition, the anterior segment of the backside of the tibial polyethylene insert was broken off and freely moving within the joint. The displaced insert changed its position during flexion and extension (Fig. 4).
After removing polyethylene remnants and performing irrigation the tibial insert was replaced. Postoperatively, range of motion was from 5° to 125° of flexion. After a routine postoperative therapy the patient was relieved and discharged from the hospital.

Discussion

Analysis of 391,913 primary TKAs showed that 36,307 (9.3%) revisions were performed due to loosening, infection, periprosthetic fractures and other reasons, among those revisions due to implant failures rates 0.44% [20]. Other authors reported revision rates related to implant failure in range from 0.073 to 0.94% [7, 15, 18].

Several researchers reported excellent postoperative TKA outcomes using mobile bearing e-motion® floating platform with a cruciate retaining design [5, 10, 13]. They believe that limitation of the platform movement during the flexion, extension and rotation prevents dislocations and early failure of the insert. However, our studies showed some cases [17, 24] where theoretically an increase in tibial insert failures should have been expected. Therefore, authors consider it not sufficient to rely only on kinematic limitations in clinical practice.

Several phenomena were described in literature as reasons for dislocation of the tibial insert in mobile bearing prosthesis: impingement of the insert with osteophyte or soft tissues during activities, incorrect positioning of prosthesis components, discrepancy of extension and flexion balance or ligaments weakness [8, 13, 22]. However, neither clinical examinations nor intra-operative findings revealed above as possible reasons for dislocation. Only a similar mechanism of crepitus onset allows us to suppose that such fractures must evolve due to “twist-hyperflexion” in overweight patients. H. Shimagaki et al affirmed that the hyperflexion of TKA leads to a progression of a downward strength on the posterior half of the tibia polyethylene insert [21, 23] and the authors consider that in such circumstances the increase in action force and simultaneous movement of the rotation axis may result in overloading of certain parts of the insert. Finally, misbalancing of the action force can lead to fracture of tibial insert with or without dislocation. At the same time this angular friction could be a reason for damage of the posterior side of the insert before breakage, and after displacement of a broken fragment the full incongruence of the component surface and constant knee motion can lead to a damage of the tibial polyethylene insert known as «melting» (Fig. 2). Actually, the opinions and conclusions of many authors create a certain paradox where a satisfactory range of motion almost identical to physiological norm without restriction is considered to be an excellent result [10, 23], when namely good recovery of the knee joint motion leads to serious complications.

Despite multiple research, improvements in implants quality, surgical technique and clinical outcomes [6, 14, 16], based on own practical experience and some case reports contributed by other researchers [12, 19, 24] the authors consider that bio-physiological and biomechanical aspects of total knee arthroplasty and knee joint prosthesis should be thoroughly studied and implemented into the clinical practice. In the described cases, multiple damage of the insert due to flexion instability and “twist-hyperflexion” in overweight patients is perceived as the reason for failures.

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МНОЖЕСТВЕННЫЕ ПОВРЕЖДЕНИЯ ПОЛИЭТИЛЕНОВОГО ВКЛАДЫША ЭНДОПРОТЕЗА КОЛЕННОГО СУСТАВА (МОЖЕТ ЛИ ОТЛИЧНЫЙ ФУНКЦИОНАЛЬНЫЙ ПОСЛЕОПЕРАЦИОННЫЙ РЕЗУЛЬТАТ СТАТЬ ПРИЧИНОЙ ПОВРЕЖДЕНИЯ ПОЛИЭТИЛЕНОВОГО ВКЛАДЫША?)

Клинические наблюдения и обзор литературы

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Реферат

Несмотря на то, что в последние годы в производстве эндопротезов применяются усовершенствованные технологии и высококачественные материалы, число ревизионных вмешательств по причине несостоятельности имплантатов остается достаточно высоким (4,7%). В научной литературе описываются несколько причин вывихов и повреждений полиэтиленового вкладыша конструкций эндопротезов коленного сустава с мобильной платформой, а именно: неправильное позиционирование компонентов, дисбаланс стабильного и разгибательного промежутков или несостоятельность связочного аппарата. Однако, в своей клинической практике авторы не наблюдали подтверждения подобных причин. По мнению авторов, необходимо тщательно исследовать и учитывать в клинической практике физиологические и биомеханические особенности как методики тотального замещения коленного сустава, так и самих имплантатов. В описываемых случаях в качестве причины неудовлетворительных исходов авторы отмечали множественные повреждения полиэтиленового вкладыша вследствие нестабильности при сгибании коленного сустава и/или глубокого сгибания в сочетании со скручивающим усилием у пациентов с избыточной массой тела.

Ключевые слова: тотальное эндопротезирование коленного сустава, эндопротез с подвижной платформой, повреждение полиэтиленового вкладыша.

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