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HOT TOPICS

Triaging Total Hip Arthroplasty During the COVID-19 Pandemic

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Abstract

Purpose of Review The purpose of this review was to evaluate the available literature to determine what may be considered urgent indications for total hip arthroplasty, in the unprecedented setting of the worldwide COVID-19 pandemic.

Recent Findings SARS-CoV-2 is a novel coronavirus currently presenting in the form of a global pandemic, referred to as COVID-19. In this setting, multiple states have issued executive orders prohibiting "elective" surgery, including arthroplasty, in order to preserve healthcare resources. However, during this unprecedented reduction in elective surgery, there is likely to be some controversy as to what constitutes a purely "elective" procedure, versus an "urgent" procedure, particularly regarding hip arthroplasty. We reviewed the available literature for articles discussing the most commonly encountered indications for primary, conversion, and revision hip arthroplasty. Based upon the indications discussed in these articles, we further stratified these indications into "elective" versus "urgent" categories.

Summary In patients presenting with hip arthroplasty indications, the decision to proceed urgently with surgery should be based upon (a) the potential harm incurred by the patient if the surgery was delayed and (b) the potential risk incurred by the patient in the context of COVID-19 if surgery was performed. The authors present a decision-making algorithm for determining surgical urgency in three patients who underwent surgery in this context. Urgent total hip arthroplasty in the setting of the COVID-19 pandemic is a complex decision-making process, involving clinical and epidemiological factors. These decisions are best made in coordination with a multidisciplinary committee of one's peers. Region-specific issues such as hospital resources and availability of PPE may also inform the decision-making process.

Keywords COVID-19 · Coronavirus · Pandemic · Hip arthroplasty · Urgent · Elective

Introduction

Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2) is a severely contagious novel coronavirus currently presenting in the form of a global pandemic, commonly referred to as COVID-19 [1••, 2••, 3•, 4••, 5••, 6••]. The virus was first reported in December 2019 as a lower respiratory illnesses presenting in patients from Wuhan, China, with an unknown origin of infection, although subsequent investigation has determined that SARS-CoV-2 is closely related to a coronavirus strain that was isolated from Chinese chrysanthemum-headed bats in 2015 [5••, 6••, 7, 8].

Patients presenting with symptoms of COVID-19 typically complain of lower respiratory symptoms, including fever, dry cough, fatigue, muscle pain, and dyspnea. While most patients will have a mild presentation, patients primarily at risk for severe illness and/or death are those that are elderly (65 and older), immunocompromised (HIV positive or on chronic immunosuppressants), and have chronic medical comorbidities

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(heart conditions, obesity, diabetes, chronic kidney disease, liver disease, and chronic lung disease) [5••, 6••]. The exponential expansion of COVID-19 despite social distancing efforts and travel restrictions has resulted in acute shortages of healthcare resources, and hospitals in certain metropolitan areas within the USA are in danger of being overwhelmed [9••].

In the setting of the expanding pandemic, multiple states have now issued executive orders prohibiting elective surgery, with the aim of preserving healthcare resources including personal protective equipment (PPE) and intensive care unit (ICU) capacity. For example, in Texas an executive order by the Governor mandates "all licensed health care professions and all licensed health care facilities shall postpone all surgeries and procedures that are not immediately medically necessary to correct a serious medical condition of, or to preserve the life of, a patient who without immediate performance of the surgery or procedure would be at the risk for serious adverse medical consequences or death, as determined by the patient's physician" [10]. Similarly, the Surgeon General of the USA has recommended that providers "consider stopping elective surgeries" until the coronavirus threat subsides [11].

In keeping with these mandates, a significant reduction in elective total joint arthroplasty has been recognized nationwide and has been endorsed by the American Association of Hip and Knee Surgeons (AAHKS) and the American Academy of Orthopaedic Surgeons (AAOS) [12]. However, during this unprecedented reduction in elective joint arthroplasty, there is likely to be some controversy as to what constitutes a purely "elective" procedure, versus an "urgent" or "emergent" procedure, depending on the indication for surgery and the clinical condition of the patient, particularly in the setting of total hip arthroplasty. The purpose of the present article is therefore to review some of the most commonly encountered indications for primary, conversion, and revision hip arthroplasty and discuss the available evidence for what may reasonably be considered an urgent versus elective procedure, specifically in the context of the COVID-19 pandemic. The authors further present their current algorithm for determining the urgency of total hip arthroplasty (THA) in the setting of the COVID-19 pandemic and present a case series of relevant THA patients as examples.

Primary and Conversion Total Hip Arthroplasty

Elective THA

The American Academy of Orthopedic Surgeons (AAOS) has released a preliminary statement qualifying the urgency of surgeries based on tiers, ranging from "elective" to "urgent" to "emergent" [12]. Elective procedures are defined as "those with chronic problems whose surgery can certainly be delayed without significant harm to the patient or eventual outcome." Generally, uncomplicated THA falls within this description, and thus a delay in elective THA is recommended until the COVID-19 pandemic begins to subside. Chronic conditions such as osteoarthritis, non-erosive rheumatoid arthritis, non-collapsed avascular necrosis (AVN) of the femoral head, chronic sequelae of developmental dysplasia of the hip (DDH), and chronic femoral acetabular impingement (FAI) with osteoarthritis are generally not treated urgently, and a short delay in care during the several weeks to months of the COVID-19 pandemic would not be expected to result in significant harm to the patient [13–17]. For example, Nilsdotter et al. have found that SF-36 and WOMAC scores did not differ between patients with stable primary OA who waited more than 3 months for their THA compared to those that underwent THA immediately [13]. Similarly, non-urgent conversion THA indications, such as previous fracture constructs that have gone to develop stable osteoarthritis, can likely be considered elective surgery on the basis of the above criteria [18]. Such patients should be encouraged to attempt additional conservative treatment measures including anti-inflammatory medication, injections, application of ice/heat, stretching, low impact exercises, and weight loss [19].

Urgent THA

Within the escalating tiers of surgical urgency described by the AAOS, hip fractures are deemed "urgent" and should be addressed within 24–48 h during the COVID-19 pandemic [12]. Femoral neck fractures should therefore continue to be treated urgently with either hemiarthroplasty or THA, depending on the patient's age and baseline activity level [20–23]. The morbidity and mortality secondary to hip fractures are well recognized in the literature, with mortality rates in the elderly ranging between 14 and 36% within 1 year of the injury [24–32]. Additionally, Klestil et al. have investigated the threshold to which a delay in hip fracture surgery would result in worsened outcome. The authors found that in elderly patients sustaining hip fractures, early surgery was associated with reduced perioperative complications, as well as reduced mortality [33]. Furthermore, patients that had surgery within the first 48 h after injury had a 20% lower 1-year mortality [33]. These data would suggest that hip fracture and similar diagnoses should warrant urgent intervention despite restrictions on arthroplasty surgery during the COVID-19 pandemic.

There are potentially urgent surgical indications for THA other than fracture, which may compel early surgical intervention, in order to minimize morbidity or undue harm to the patient that would be incurred if surgery were delayed. For example, rapid collapse of the femoral head due to avascular necrosis (AVN), tumor infiltration, or other metabolic processes may have a similar presentation to fracture patients and thus may benefit similarly from urgent surgical intervention with THA. In addition, progressive structural bone erosion of either the proximal femur or acetabulum, as may occur in AVN, tumor, rheumatoid arthritis, or other metabolic processes, may cause increased morbidity for the patient and/or necessitate a more extensive surgical reconstruction if delayed, and urgent THA may be advisable in these patients [34–36].

Similarly, there are potentially urgent indications for conversion THA, and early intervention may be warranted in selected patients despite the COVID-19 restrictions in order to prevent worsening morbidity and poor outcome if surgery were delayed. For example, failed internal fixation of hip fractures, such as nonunion and/or collapse of the fracture construct, ultimately leads to profound functional disability and pain for an already fragile patient population [18, 37–40]. Such patients can be more functionally comparable to fracture patients and may need evaluation on a more urgent basis. Particularly in a patient with intractable pain and disability, conversion THA due to nonunion or collapse of a previous fracture construct (such as percutaneous screw fixation, compression hip screw, or cephalomedullary nail) could merit urgent intervention if functionally similar to a patient presenting with a hip fracture [18, 37–40].

In addition to the above clinical indications, when evaluating an "urgent" versus "elective" indication for THA, arthroplasty surgeons must consider the risks of immobility in conjunction with the underlying diagnosis. The resulting loss of function from osteoarthritis and other painful hip syndromes leads to a cyclical feedback loop of diminished physical activity, reduced muscular function, increased obesity, worsened medical comorbidities, and the development of psychological factors relating to the pain and dysfunction [41]. Chronic immobility in this setting may also put the patient at elevated risk of deep vein thrombosis (DVT) or pneumonia [42]. Compared to the general population, patients who are chronically immobile are at a significantly increased risk for pneumonia, urinary tract infections, deep vein thrombosis, and all-cause mortality [42–44]. Furthermore, patients with osteoarthritis are at increased risk of falling, with 50% of OA patients self-reporting a fall every year [45–47]. Therefore, the risks of clinical deterioration, immobility, and frequent falls should be considered when determining the level of urgency for an individual patient. Adequate documentation of the patient's clinical condition is crucial in this regard, and ultimately, it is the patient's orthopedic surgeon in conjunction with the treating facility that may determine the level of urgency and indication for proceeding with THA in the setting of the COVID-19 pandemic.

Revision Total Hip Arthroplasty

Elective Revision THA

While no specific guidelines regarding revision total hip arthroplasty are evident in the AAOS COVID-19 position statement, the defined language of "elective" versus "urgent" indications may be extrapolated to the revision THA setting to guide surgeon decision making. Stable, chronic problems in which surgery can certainly be delayed without significant harm to the patient or eventual outcome should be delayed in the setting of COVID-19 pandemic. For example, elective head/liner exchange for polyethylene wear in a minimally symptomatic patient with minimal osteolysis may be reasonably delayed without causing additional patient morbidity [48]. Similarly, one- or both-component revisions for suspected aseptic loosening in a stable patient without progressive bone loss may be potentially delayed during the pandemic without resulting in additional harm to the patient [48, 49]. Consistent with the conservative modalities for primary THA candidates, non-operative treatments including anti-inflammatory medication, application of ice/heat, stretching, low impact exercises, and weight loss may be indicated while these patients await surgery [19].

Urgent Revision THA

Clearly, there are indications for revision THA that could compel urgent surgical intervention during the COVID-19 pandemic. For example, the AAOS has identified periprosthetic joint infection as a procedure that necessitates immediate intervention [12]. Periprosthetic hip infections remain a major complication of total hip arthroplasty in the USA [50–53]. Deep periprosthetic hip infection is associated with a mortality rate of 5.5–8% at 1 year, and delay in treatment may result in additional morbidity for the patient [52–54]. Additionally, the differentiation between an acute vs chronic periprosthetic joint infection is time-sensitive; to delay surgery in the setting of an acute infection may mean the difference between a successful irrigation and debridement with implant retention, versus the need for a considerably more morbid two-stage revision [55, 56]. Additional urgent indications for revision THA may include an irreducible prosthetic dislocation or a periprosthetic fracture; in such cases delay of treatment could confer significant additional morbidity to the patient, and urgent revision THA may be preferred despite the current COVID-19 restrictions [57].

Urgent revision THA may be additionally warranted depending on the clinical situation of the individual patient.

For example, a patient suffering from a THA dislocation may be reducible via closed means, but a persistently unstable and recurrently dislocating patient is at elevated risk for future dislocation events, which may result in additional harm, cost, and potentially significant injury if the instability is not addressed [58]. Recurrent instability diminishes confidence in the prosthesis, thus restricting activity [59]. Each episode of a dislocated prosthesis is significantly distressing and painful, requiring a visit to the emergency department as well as sedation to allow for reduction maneuver [60]. If recurrent instability is causing significant morbidity in the patient, and delay of revision arthroplasty might result in additional harm to the patient as indicated above, then revision surgery may be considered in a more urgent manner.

In general, the decision to proceed urgently with aseptic revision THA for progressive loosening or osteolysis in the setting of the COVID-19 pandemic should be based on the severity of the patient's clinical and radiographic presentation. A patient with worsening polyethylene wear and progressive osteolysis surrounding the socket or stem may risk continued bone loss and subsequent failure of the implant. Such a patient may progress from a requiring a simple head/liner exchange to becoming a major reconstructive challenge with significant morbidity, if the osteolytic process is not arrested in a timely fashion [35, 61, 62]. Additionally, loose implants that are eroding the patient's bone stock similarly may result in additional patient harm if not addressed early, and progressive loss of bone stock may require a more complicated reconstruction with potentially more patient morbidity. Earlier intervention may also prevent the occurrence of periprosthetic fracture due to reduced bone quality or quantity [34, 62, 63].

A significant burden of metal-on-metal revision THA still exists in the COVID-19 era, and some of these patients may present with urgent indications for surgery. Mildly symptomatic patients with stable serum cobalt/chromium ion levels and minimal bony or soft tissue changes may be safely delayed. However, floridly erosive pseudotumor formation with significant bone and soft tissue destruction may necessitate more urgent intervention in order to prevent additional bone and soft tissue loss, abductor damage, and deep vein thrombosis [64]. As with any primary or revision candidate during the COVID-19 pandemic, the patient's presenting clinical picture may help to inform the clinician as to the individual patient's risk, and the harm which may be incurred if surgery is delayed.

COVID-19 Algorithm for THA

Based on the available literature and continued monitoring of the COVID-19 pandemic in our region, our institution has adopted the following algorithm for determining surgical urgency of hip arthroplasty procedures in the setting of the COVID-19 pandemic (Fig. 1). Once a patient has been determined to be a candidate for arthroplasty surgery, the next step is to consider whether a short postponement of several weeks could potentially result in significant harm to the patient. If the answer is "No," then it is recommended that surgery be delayed. Obviously, urgent scenarios such as fractures or infections are recommended to proceed without delay.

For surgical indications other than fracture or infection in which delay might result in significant harm to the patient, the next question to consider is whether this patient has identifiable risk factors that might portend a worse outcome in the setting of COVID-19 infection. This includes but would not be limited to heart conditions, obesity, diabetes, chronic kidney disease, liver disease, and chronic lung disease. If the patient's individual COVID-19 risk is deemed to be greater than the risk incurred by deferring surgery, then surgery is delayed. However, if the individual patient's COVID-19 risk is felt to be less than the risk potentially incurred by delaying surgery, then surgery would proceed in an urgent manner.

Case Examples

Case 1

The patient is a 55-year-old female with a longstanding history of bilateral hip pain due to known avascular necrosis. Her right hip was initially more severe both clinically and radiographically, and she underwent elective right total hip replacement prior to the onset of the COVID-19 pandemic. However, in the setting of the COVID-19 elective surgery restrictions, she re-presented to our arthroplasty service with rapid deterioration and intractable pain of the left hip over the previous few weeks. She stated she could not safely transition from a sitting to standing position. Despite attempted use of the walker, she was unable to ambulate, felt unstable on her left side, and stated she was acutely afraid of falling and causing additional injury. She was essentially bedridden due to this clinical deterioration. Radiographic analysis of the left hip demonstrated interval progression of AVN, with collapse of the articulating surface of the femoral head. The collapsed femoral head was now eroding superolaterally through the acetabulum, creating a superolateral rim defect (Fig. 2). Importantly, the patient had no previous medical history that would confer significantly increased risk in the setting of COVID-19, such as heart disease, obesity, diabetes, chronic kidney disease, liver disease, or chronic lung disease.

After presentation of the case to a multidisciplinary peer-review panel at our institution, the unanimous decision was made to proceed urgently with primary THA. It was determined that delay of this surgery could result in continued erosion of the acetabulum, potentially requiring a more challenging and extensive reconstruction and thus conferring

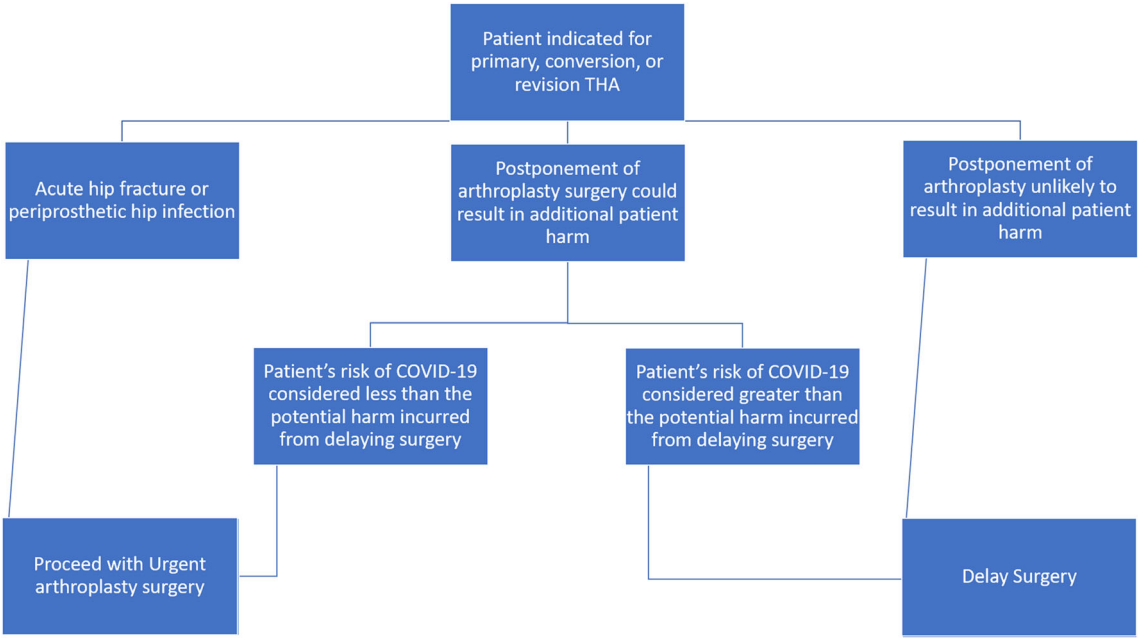

Fig. 1 Decision-making algorithm for determining urgency of hip arthroplasty surgery during the COVID-19 pandemic

additional harm to the patient. Additionally, her rapid clinical deterioration made her a considerable fall risk, and early intervention was felt to be the best option to prevent potential future injury. The patient subsequently underwent uncomplicated direct anterior THA and was discharged home on postoperative day one.

Case 2

The patient is a 76-year-old female who suffered a subcapital femoral neck fracture at an outside institution in November of 2019, at which time she underwent closed reduction and percutaneous pinning. However, she later presented to our arthroplasty service during the COVID-19 pandemic, complaining of rapidly worsening left-sided hip pain with the inability to bear weight. Per the patient's daughter, her clinical condition had deteriorated particularly over the previous 2 weeks, with multiple episodes of stumbling and tripping due to the worsening hip pain and inability to bear weight on the left side. The patient stated that night-time was particularly dangerous for her, as she had extreme difficulty with toileting due to the pain and dysfunction in her left hip, and was fearful that she may injure herself in a fall. By the time of presentation, the patient reported she was essentially confined to bed due to her deteriorating clinical status. Plain radiographs demonstrated the previous percutaneous fixation of the patient's

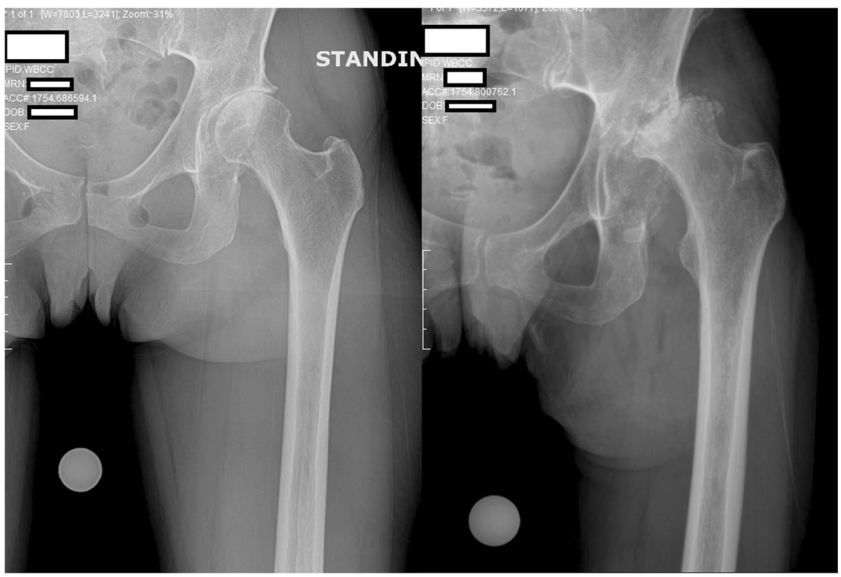

Fig. 2 Sequential left hip radiographs demonstrating interval progression of AVN, with collapse of the articulating surface of the femoral head. The collapsed femoral head is now eroding superolaterally through the acetabulum, creating a superolateral rim defect

subcapital femoral neck fracture with three cannulated screws. However, the fracture construct was seen to have collapsed into nonunion, with a persistently visible fracture line and shortening of the femoral neck, with resulting partial backing-out of the screws laterally (Fig. 3).

The case was referred to a multidisciplinary peer-review panel at our institution. The unanimous decision was made to proceed urgently with conversion THA. Other than advanced age, the patient had no past medical history that would put her at additional risk in the setting of COVID-19, and she was felt to be at significant risk for future falls, injury, and potentially greater morbidity if the surgery was to be delayed. Her clinical status was essentially comparable to a hip fracture patient. She subsequently underwent uncomplication conversion THA and was discharged home on post-operative day two.

Case 3

This patient is a 71-year-old female approximately 1 month out from an elective total hip arthroplasty, who was urgently referred to our arthroplasty service for new onset of serosanguinous drainage from her previously dry wound. The patient complained of increasing pain, swelling, and warmth in the region of her incision over the previous several days. On exam, her posterolateral incision was tender to palpation with blanching erythema of the peri-incisional skin. At the proximal third of the incision was a 1-cm area of wound breakdown with thin, active serosanguinous drainage. Her C-reactive protein was 0.74 mg/dL, and erythrocyte sedimentation rate was 46 mm/h. Notably, this patient did have some risk factors putting her at increased risk in the setting of a COVID-19 infection (BMI > 35, history of asthma); her acute clinical picture was compelling enough to consider proceeding with surgery in an urgent manner.

The case was referred to a multidisciplinary peer-review panel at our institution. The unanimous decision was made to proceed urgently with irrigation and debridement with modular component exchange. Due to the concerning clinical picture of a recent THA patient with new onset pain, swelling, tenderness, and new wound drainage, the benefits of early intervention for treatment of a potential periprosthetic hip infection were felt to outweigh the potential risks in the setting of the COVID-19 pandemic. The patient successfully underwent irrigation and debridement with exchange of the modular femoral head and polyethylene liner, and intraoperative cultures subsequently grew pan-sensitive coagulase-negative *Staphylococcus lugdunensis*. An infectious disease consult was obtained, and the patient was managed postoperatively with intravenous antibiotics.

Fig. 3 Anteroposterior pelvis radiograph demonstrating percutaneous cannulated screw fixation of a valgus-impacted femoral neck fracture. The fracture construct is seen to have collapsed into nonunion, with a persistently visible fracture line and shortening of the femoral neck, with resulting partial backing-out of the screws laterally

Conclusion

During the unprecedented restrictions being placed on total hip arthroplasty in the setting of the COVID-19 pandemic, there are inevitably some patients who present with more urgent indications that will require early surgical intervention. The present paper provides a thorough literature review, case series, and decision-making algorithm to assist the arthroplasty surgeon in determining surgical urgency for hip arthroplasty candidates. The authors would further suggest that such decisions are best made in coordination with an institutional multidisciplinary panel or committee of one's peers. Finally, the authors recognize that the decision to proceed with urgent hip arthroplasty during the COVID-19 pandemic must also be weighed in the context of the region or city in which the surgery is being performed. Each state is affected with varying intensity by the present pandemic, and region-specific issues such as hospital resource conservation and availability of personal protective equipment may inform the decision-making process.

Compliance with Ethical Standards

Conflict of Interest James Rizkalla, Brian Gladnick, Aamir Bhimani, Dorian Wood, Kurt Kitziger, and Paul Peters declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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