Medical Sciences

Renal and Gastrointestinal Considerations in Joint Replacement Surgery

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Renal and gastrointestinal diseases affect a significant portion of the general population. The process of decision making regarding surgical clearance and pre-operative management of the various complexities and medical conditions associated with these diseases hence becomes crucial. To optimize postoperative outcomes, the considerations for the care of this patient population revolve around effective management of hemostasis and electrolyte status. This subset of conditions is uniquely important with regard to the negative impact of improper administration of medications and perioperative care on patients' prognoses. A thorough understanding and knowledge of standards of care and treatment guidelines for patients with renal dysfunction and gastrointestinal disease assures comprehensive preoperative planning and surgical clearance. This may ultimately lead to improvement of surgical outcomes and potential decrease in postoperative morbidity and mortality. *Journal of Nature and Science, 1(2):e46, 2015.*

Renal disease | gastrointestinal disease | preoperative | medical clearance | joint replacement

Introduction

Renal diseases as well as gastro-intestinal disease affect a large portion of orthopedics patients, requiring additional understanding of the intricacies involved in their care. Chronic kidney disease (CKD) is a progressive disorder that typically results from glomerulonephritis, diabetes mellitus and hypertension, with nearly 75% of CKD diagnoses caused by these conditions[1-4]. Acute kidney injury (AKI), a milder decrease in renal function, is often linked to iatrogenic causes such as perioperative anesthesia and medications. Estimates of prevalence for AKI suggest that it may affect 1% of all hospitalized patients, and it is a well-documented independent predictor of poor health outcomes[5-7]. Gastrointestinal diseases encompass a wide spectrum of conditions. Liver cirrhosis affects up to 1% of the U.S. population while annual incidence of irritable bowel disease (IBD) reaches 29/100,000 per year[8-10]. Consideration and knowledge of the major co-morbidities associated with the disease processes of kidney dysfunction and gastrointestinal disease and their respective medical treatments are key components of pre-operative medical clearance of orthopaedic patients.

An ample knowledge of the disease manifestation and treatment guidelines for patients with gastrointestinal and renal pathologies would yield a substantial decrease in postoperative morbidity and mortality. Both conditions, in particular the renal system, have a preponderance of established literature detailing the disease origins, variations, and modalities of care. Vigilant evaluation of markers for disease management and prudent perioperative management of medication dosing are paramount. In this review we provide recommendations and considerations for the care of patients with renal and gastrointestinal conditions.

Renal Considerations

Chronic Conditions

CKD is a progressive disorder defined as a glomerular filtration rate (GFR) <60 mL/min per 1.73 m^2, which represents a loss of half or more of the normal adult renal function level. The National Kidney Foundation (NKF) provides thorough recommendations for both proper disease evaluation and classification – details of which exceed the scope of this review [11,12]. Progression of CKD leads to kidney failure and end stage renal disease (ESRD), defined by the NKF as CKD with a GFR of less than 15 mL/min per 1.73 m^2 [11]. Both CKD and ESRD are predictive of prolonged hospital stay and increased all-cause mortality following surgery[13-20]. This population is predisposed to multiple possible peri- and post-operative complications, due to the disease process itself, its treatment and the associated comorbidities. These include endothelial dysfunction and hypercoagulability, elevated serum homocysteine, microalbuminuria, and accelerated vascular calcification due to deficient mineral metabolism[16,18,19].

Advanced stage renal disease is an independent risk factor for increased post-operative cardiovascular mortality and morbidity[15]. A longstanding correlation exists between patients treated with prolonged renal replacement therapy and cardiovascular complications[21,22]. Patients with CKD (all stages) with superimposed cardiovascular disease (CVD) are up to 10 times more likely to die before even reaching a classification of ESRD and can expect their CVD to progress at twice the normal rate when compared to patients with CVD only [23].

Several cardiovascular considerations should be highlighted in CKD patients. Atherosclerosis is a common form of arterial vascular disease seen more extensively in patients with renal dysfunction. It may manifest as ischemic heart disease (angina), myocardial infarction, cerebrovascular disease, peripheral vascular disease, or congestive heart failure[24]. In 2011, the prevalence of CHF reached up to 31.2% among all Medicare CKD patients[4].

The prevalence of atrial fibrillation (AFIB) in the CKD population is as high as 25%[4]. Uremia, by interfering with the autonomic nervous system and affecting baroreceptor function, predisposes to a higher risk for the development of arrhythmias and AFIB [25]. This leads eventually to an increased risk of thromboembolic events.

CKD patients are noted to have a high incidence of concomitant hypertension. In 2011, as many as 63% of these patients were receiving angiotensin converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB) and up to 47% received beta blockers, as a pharmacotherapy to control their blood pressure and renal disease progression [26]. Many anaesthetic agents induce peripheral vasodilation and cardiac depression. In patients maintained on ACEI or ARB perioperatively, this will accentuate the risks for hypotension and subsequent renal hypoperfusion, leading to a further potential intraoperative renal insult[27]. Craig et al. indicate that perioperative development of hypotension relative to preoperative levels is a risk for intolerable further renal damage [28]. They recommend individualized treatment of hypotension as opposed to the absolute stringent measure of <90 mm Hg [28].

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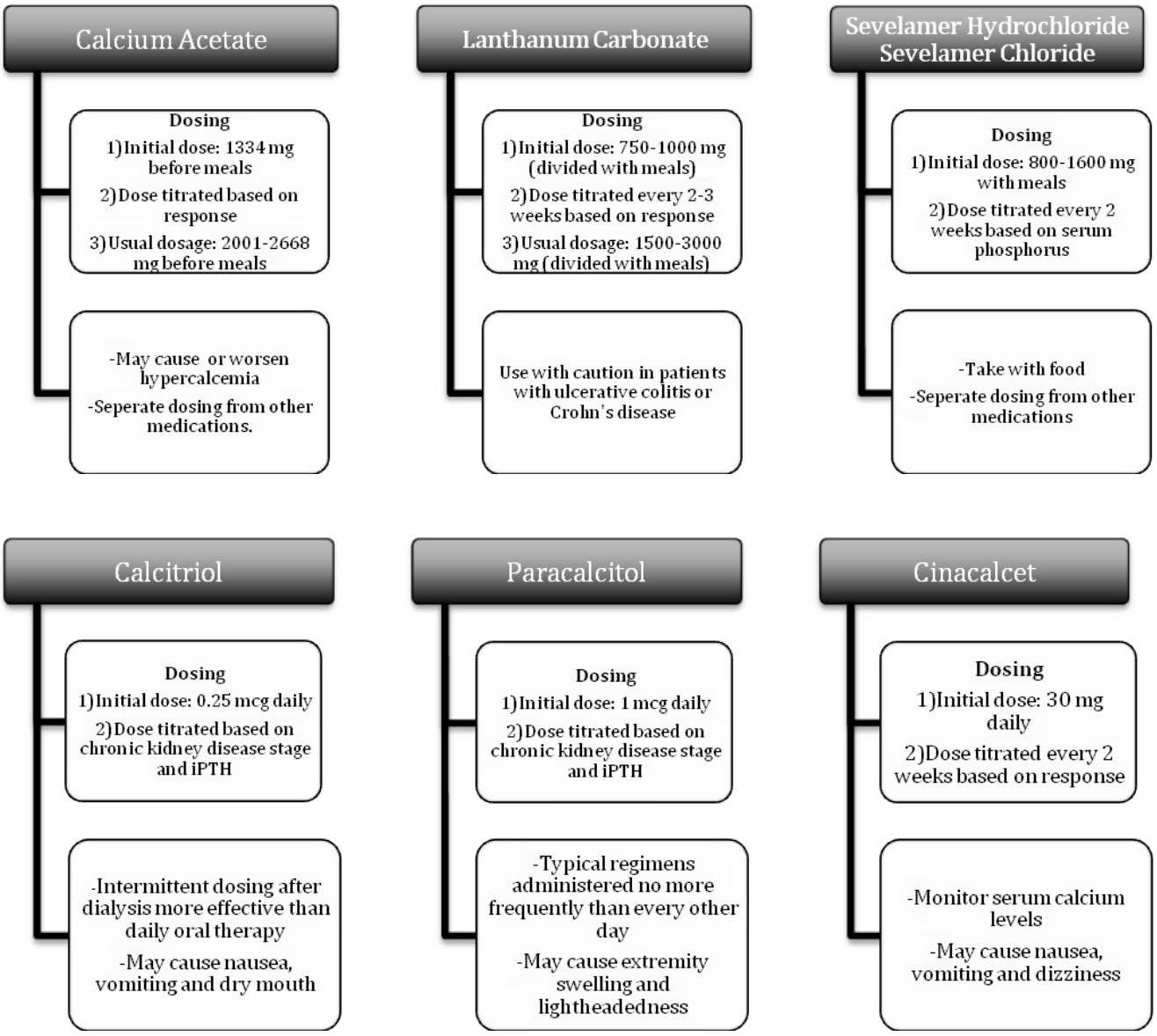

Figure 1: Pharmacologic management of CKD-mineral bone disorder.

The renal system plays a pivotal role in hematopoiesis. Through the synthesis of erythropoietin, the kidneys drive differentiation and proliferation of erythrocyte progenitor cells and thus control erythrocyte concentration [29,30]. It is estimated that up to 18% of stage 3 patients (GFR <30 mL/min/1.73 m^2) and nearly 60% of those in stages 4-5 (GFR <30 mL/min/1.73 m^2) are anemic[31]. Epoetin alfa, approved in 1989, was the first erythropoiesis-stimulating agent (ESA) developed for the treatment of anemia in CKD patients [32]. Anemia is common in the setting of orthopaedic surgery, and the condition confers increased risk of blood transfusion and peri-and postoperative morbidity and mortality [33]. Anemia in CKD (but not CKD alone) was associated with a higher risk of blood transfusion, increased length of hospital stay, periprosthetic joint infection, and increased incidence of 30-day readmission in orthopaedic patients [34-37]. A significant risk for infection is associated with blood transfusion[38]. Of particular interest, more restrictive transfusion strategies in orthopaedic patients had significantly reduced risk ratios for the development of healthcare-associated infections[38-44].The Kidney Disease Outcomes Quality Initiative (KDOQI) and Network for Advancement of Transfusion Alternatives (NATA) both recommend treatment of anemia with ESA[33]. This algorithm proved to reduce the transfusion requirements in CKD patients. However, the safety and efficacy of this medication is being questioned in recent trials. The CHOIR study showed that treatment of anemic non-dialysis CKD patients to Hb of 13.5 g/dL greatly increased the risk of cardiovascular complications and death compared with Hb levels of 11.3 g/dL[45]. In another study, Pfeffer et al. demonstrated that ESA use significantly raised incidence of stroke[46]. In addition, a rise in risks of cardiovascular accidents has also been shown in more recent trials[47,48]. The risks and benefits of administration of these drugs for patients with CKD-associated anemia should be individualized and further investigated[32,45-50].

Dialysis and transplantation are the final recourse when renal failure has progressed beyond the point of independent functionality. Dialysis-dependent patients have longer hospital stays, higher surgical and postoperative complications, and mortality rates when compared to those not requiring intervention[4,15,51-56]. Dialysis patients with superimposed DM and hypertension are predisposed to even higher risks[52]. Of particular significance, ESRD patients on dialysis or those who received kidney transplant are at a greater risk for complications following total hip arthroplasty (THA) or total knee arthroplasty (TKA)[57-62]. Renal impairment is proposed as an independent risk factor for both periprosthetic joint infection (PJI) in TKA and elevated 90-day readmission risk in THA[63,64].

Table 1: RIFLE classification stages and criteria for defining AKI[75]

Stage	GFR and SCr Criteria	Urine Output Criteria
Risk	SCr 1.5x baseline or GFR decrease >25%	<0.5 mL/kg/hr for 6 hours
Injury	SCr 2x baseline or GFR decrease >50%	<0.5 mL/kg/hr for 12 hours
Failure	SCr 3x baseline or GFR decrease >75% or SCr level ≥4 mg/dL	<0.3 mL/kg/hr for 24 hours or anuria for 12 hours
Loss	Complete loss of kidney function > 4 weeks	
End Stage Renal Disease	Complete loss of kidney function > 3 months	

Table 2: AKIN stages and criteria for defining AKI[75]

Stage	SCr Criteria	Urine Output Criteria
Stage 1	Increase in SCr >0.3 mg/dL or SCr 1.5-2x baseline	<0.5 mL/kg/hr for 6 hours
Stage 2	SCr 2-3x baseline	<0.5 mL/kg/hr for 12 hours
Stage 3	SCr >3x baseline, or SCr >4 mg/dL with an acute rise of >0.5 mg/dL, or receiving renal replacement therapy	<0.3 mL/kg/hr for 24 hours or anuria for 12 hours

Frequent complications are reported among patients on chronic hemodialysis undergoing hip fracture repair. In this patient population, Karaeminogullari et al. reported a significant correlation between length of hemodialysis and postoperative mortality rates[54]. The recommended treatment for these patients with intra-trochanteric and non-displaced femoral neck fractures is osteosynthesis, while hemiarthroplasty is indicated for those with displaced femoral neck fracture[54]. THA for transplant patients and those on dialysis are associated with high mortality rates, and should be reserved for those who demonstrate a considerable potential for positive post-operative outcomes[58,65].

The current literature indicates that patients undergoing hemodialysis are at a greater risk for perioperative complications when compared to those receiving peritoneal dialysis.

Patients on hemodialysis have a 31% higher incidence of hip fracture compared to those receiving peritoneal dialysis.[56] When comparing bone lesions between these two patients population, it is noted that those on peritoneal dialysis present with low-turnover lesions, while those on hemodialysis regimen have high-turnover lesions [66]. This observation can be in part explained by the significantly higher parathyroid hormone (PTH) levels in hemodialysis patients, representing increased risk of bone depletion and resorption[66]. In addition to osteodystrophy, steroid use in chronic hemodialysis patients may pose a further burden on bone deterioration[67].

The management of bone mineral disturbances in these patients involves maintaining physiologic levels of PTH and stimulating vitamin D receptors[68]. The pharmacologic classes of available treatment options include phosphate binders, vitamin D analogs, and calcimimetics[68] (Figure 1).

There is no reliable evidence that agents such as dopamine, diuretics, calcium channel blockers, ACEIs, N-acetyl cysteine (NAC), atrial natriuretic peptide (ANP), sodium bicarbonate, antioxidants, ESA, and selected hydration fluids exert any renal protective influence during surgery[69]. Unexplained preoperative decline in renal function merits postponement of the procedure and meticulous investigations towards identification of any possible insult reason and the condition rectified[70]. Maintaining the patient's hydration and fluid balance remains the most effective method for preventing further renal damage[71-73]. The proper adjustment of drug dosages, taking into consideration the patient's impaired renal function, must be considered in all stages of the surgical process[74].

The Acute Setting

Acute kidney injury (AKI) is the rapid loss of renal function leading to a decrease in GFR and urine output, and an accompanying derangement of normal serum electrolyte levels. Several methods have been developed to classify acute kidney injury based on serum creatinine (SCr) levels, GFR, and urine output. The two most commonly used systems are the RIFLE and the Acute Kidney Injury Network (AKIN) classifications[75]. The RIFLE classification defines five stages of acute kidney injury (listed in Table 1). The AKIN criteria define AKI as a rapid (within 48 hours) decline in kidney function, and classify it into three stages (listed in Table 2).

The incidence of AKI reaches up to 5% of all hospitalized patients with approximately 30-40% of all cases occurring in surgical patients[5,76]. This incidence varies with the type of surgery, with the highest being associated with cardiac surgery, vascular surgery, and liver transplantation[7,27,75,77]. A wide range of values have been reported for the incidence of AKI following orthopedic surgery, from as low as 0.55% following hip and knee arthroplasty, to as high as 16% following hip fracture surgery[78,79]. The average incidence of developing AKI following all orthopedic procedures has been reported to be approximately 9%[7].

The causes of AKI can be classified as pre-renal, intrinsic, or post-renal. Pre-renal AKI is the result of hypoperfusion of the kidney, intrinsic AKI is the result of direct damage to the renal parenchyma, and post-renal AKI results from kidney outflow obstruction[80]. Multiple studies have identified risk factors for the development of AKI following orthopedic surgery, including, but not limited to, pre-existing kidney disease, heart disease, vascular disease, diabetes, and perioperative dehydration[7,78,79,81]. Another commonly identified risk factor contributing to the development of AKI is the use of nephrotoxic medications, such as non-steroidal anti-inflammatories (NSAIDs), ACEIs, ARBs, aminoglycoside antibiotics, and IV contrast dye[7,27,75-77,79,80]. Through the inhibition of prostaglandin synthesis, NSAIDs cause vasoconstriction of the glomerular afferent arteriole, resulting in hypoperfusion of the kidney[75]. Contrast material can cause renal vasoconstriction, similarly leading to hypoperfusion and AKI[75]. ACE inhibitors and ARBs decrease blood pressure and inhibit the kidney's autoregulatory mechanisms, leading to decreased perfusion and potential renal injury[75,82]. The rates of AKI in orthopedic patients have been found to be significantly higher on ACE inhibitors or ARBs[82]. Certain medications, such as aminoglycosides, cause direct nephrotoxicity in large concentrations. This explains the higher rates of AKI witnessed with the use of gentamicin, an aminoglycoside, when compared to cephalosporins as surgical prophylaxis for orthopedic patients [75,83].

Acute kidney injury is often a self-limited disease, with reports of up to 82.5% of patients that developed AKI following orthopedic procedures returning to baseline pre-operative renal function. However, patients that returned to baseline renal function post AKI didn't show significant difference in mortality rates when compared those with sustained renal injury, reflecting possible serious sequelae associated with the of AKI [7]. The development of AKI following hip fracture was associated with a significantly increased cost, longer hospital stay, higher rate of acute, 30-day, and 120-day mortality, and post-operative complications[7,79,81]. A similar association is seen in patients developing AKI following total joint arthroplasty[78]. While not specific to orthopedic procedures, several other studies assessed the effects of AKI on the outcomes of non-cardiac surgical procedures. The consensus of these studies is that AKI leads to significantly higher rates of mortality, morbidity, and length of hospitalization following surgical procedures[5,27,75-77,84]. Thus, identification of patients at risk for AKI pre-operatively is critically important for ensuring optimal surgical outcomes.

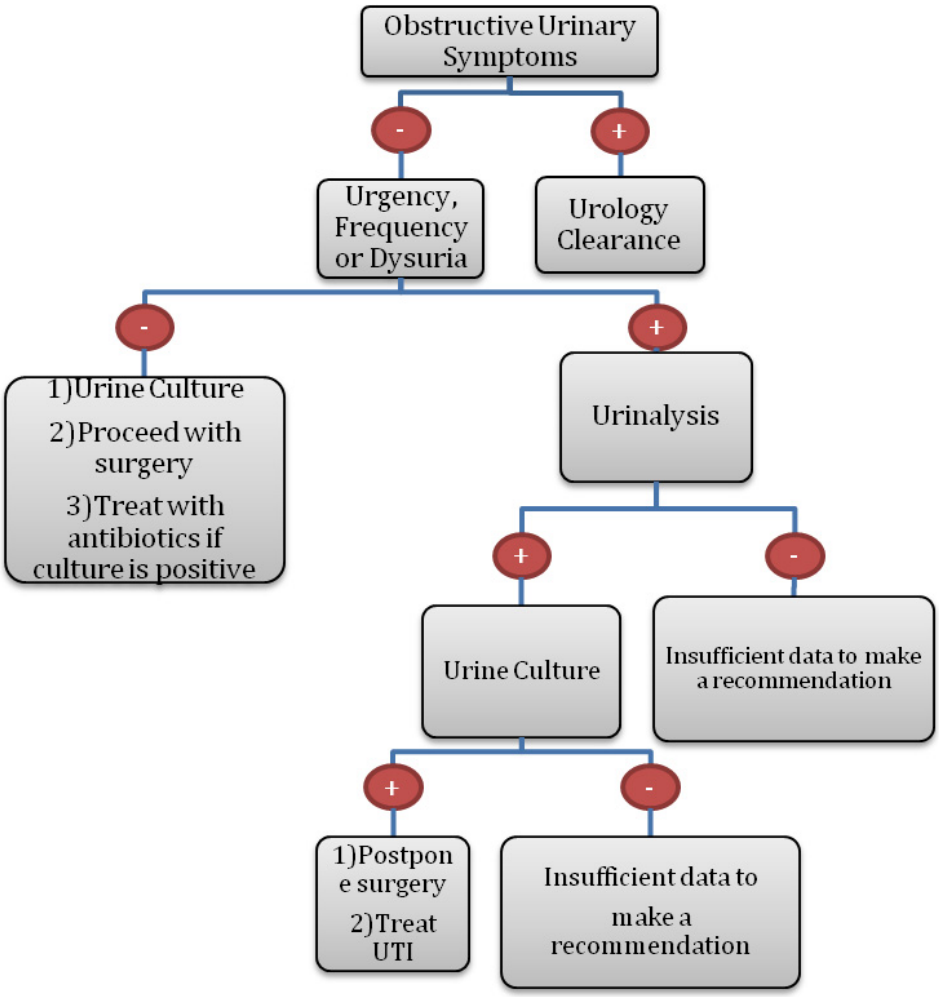

Figure 2: Algorithm for pre-operative clearance for orthopedic surgery for patients with urinary symptoms

When considering a patient for orthopedic surgery, the surgeon should identify patients at risk for developing AKI and minimize it by optimizing pre-, intra-, and post-operative conditions. The RIFLE and AKIN criteria define AKI using GFR, SCr, and urine output, so monitoring of these parameters post-operatively is important for early disease recognition. Serum creatinine, though, may take up to 48 hours to rise when at least 50% of a patient's nephrons have been damaged [75,81]. Several biomarkers are proposed as potential early indicators of AKI, such as cystatin C and neutrophil gelatinase-associated lipocalin (NGAL)[27,75,76,81]. However those are not routinely used, and a decrease in urine output, either intra- or post-operatively, remains the most useful early marker for AKI[27,75,76,81]. Several factors should be considered when identifying patients at risk for the development of AKI. First the recognition of risk factors for AKI development is important for identifying patients in need of close monitoring post-operatively[79]. Second, the type of orthopedic procedure appears to influence the risk of developing AKI, with the highest post-operative incidences generally reported following hip fracture surgery[79,81]. These procedures are associated with severe hemorrhage, and there is often a delay in fluid administration, which exacerbates the dehydration and might accelerate the decline in renal function[85]. The maintenance of adequate volume status and hydration perioperatively ensures a proper renal perfusion, which in turn decreases the risk of developing AKI[7,27,75,77,84,85]. Similarly, optimization of cardiac output, hemoglobin levels, and intra-operative blood pressure are other important factors involved in maintenance of renal perfusion and oxygenation[7,27,75,77]. Another measure to minimize the risk of renal damage is the discontinuation of any potentially nephrotoxic medications[27,75,84]. ACE inhibitors and ARBs should be discontinued on the day of surgery and not restarted until the postoperative renal function stabilizes at the baseline levels[75]. The use of NSAIDs should be cautious in high-risk patients, and avoided in hypovolemic ones[75]. The administration of IV contrast with proper hydration with an isotonic fluid minimizes the risk of damage to the kidneys[75].

Urinary Tract Infections

A urinary tract infection is defined by the presence of urinary urgency, frequency, and dysuria in the presence of bacteria in the urine[86]. Asymptomatic bacteriuria, on the other hand, is the presence of bacteria in the urine, generally defined as more than 100,000 colony forming units (CFU)/mL, without any symptoms[86]. UTIs are the most common nosocomial complication after total joint arthroplasty[87]. The incidence of UTIs is reported to be between 0.7-2.4% following total hip and knee arthroplasties, and reaches up to be 15% in patients with severe urinary retention[88]. The incidence of UTIs following all orthopedic procedures is approximately 10%[87].

The single most important risk factor for the development of a UTI is the presence of a urinary catheter[87]. The risk increases by 5-10% for every day of catheterization after 48 hours, and the median time to onset of a UTI is 6.5 days[87,89]. Patients with a urinary catheter for more than two days following surgery are substantially more likely to develop a UTI than those with a catheter for less than two days, and policies to minimize the length of post-operative catheterization following orthopedic procedures have been shown to lead to significantly lower rates of UTIs[87,89]. Urinary retention is also a major risk factor for the development of UTIs, and the use of an indwelling catheter for a short duration actually leads to fewer UTIs when compared to a straight catheter on an as-needed basis or not treating the retention[86].

Currently, no consensus exists on the need to treat UTIs prior to orthopedic surgery, or on the relationship of perioperative UTIs to complications following orthopedic procedures[90]. Several studies have concluded that UTIs are associated with the development of postoperative complications, such as wound infections, delayed wound healing, joint infection following total joint arthroplasty, and the need for earlier revisions following arthroplasty[86,91,92]. Other studies, however, have found no relationship between perioperative UTIs and the risk of wound infection following arthroplasty[90]. The testing for and treatment of asymptomatic bacteriuria is unwarranted, due to the lack of association with post-operative complications [88,93]. An algorithm has been developed for pre-operative clearance of patients with urinary symptoms for orthopedic surgery (Figure 2)[86]. However, given more recent data calling into question the association of UTIs with post-operative complications and the unnecessary need to treat asymptomatic bacteriuria, the proposed algorithm requires further investigation to determine its validity.

Gastrointestinal Considerations

Inflammatory Bowel Disease

The two main subtypes of inflammatory bowel diseases (IBD) are ulcerative colitis (UC) and Crohn's disease (CD), both chronic and relapsing [94,95]. These conditions cause chronic debilitating pain and fatigue without noticeably affecting the mortality rates of the affected individuals[9,10,96]. The annual incidence of IBD in the United States and Northern Europe reaches up to 19/100,000 per year and 29/100,000 per year, respectively[9,10].

In UC, inflammation of the gastrointestinal tract (GIT) involves the mucosal layer in a continuous pattern and is localized most commonly in the colon, cecum, and rectum[94]. Patients typically complain of abdominal cramping and bloody diarrhea mixed with pus or mucus[94]. CD is notorious for affecting the GIT in a skipping, non-continuous fashion, with transmural lesions that might involve any part of the tract.

The extra-intestinal manifestations of IBD, such as arthritis and hemostatic disturbances, contribute to significantly higher postoperative complications rates [97]. Peripheral joint involvement constitutes the major arthritic complaint in IBD patients and is present in 4.5% of patients at time of initial IBD diagnosis, 12% at six years after diagnosis, and 30% at twenty years follow up[98,99]. While this is a non-erosive or deforming arthritis, up to 6% of IBD patients develop ankylosing spondylitis that progressively leads to spinal fusion[99]. These are important considerations for surgical clearance as they may impede the postoperative rehabilitation course.

The chronic blood loss from GI bleeding, with a superimposed chronic inflammatory state, predisposes IBD patients to anemia that might be severe enough to require blood transfusions[95,100,101]. It is important to note that CD patients may be even at a higher risk of anemia due to duodenal inflammation and the subsequent iron malabsorption and deficiency[102]. Preoperative autologous blood transfusions, although associated with a lower transfusion-induced red cell alloimmunization, have been shown to decrease preoperative hemoglobin levels in patients donating 4 weeks prior to surgery [103-105]. Hence, providing parenteral iron replacement prior to orthopaedic procedures may remain the intervention of choice to minimize anemia-associated complications[102,106]. The administration of 900 mg intravenous iron sucrose through a 2-3 weeks period prior to surgical procedures shows an optimal increase of hemoglobin levels in these anemic patients[106].

The potential hemostatic instability is further pronounced in IBD patients by the increased platelet activation due to the inflammation-induced hyper-coagulable state, predisposing patients to a higher risk of thromboembolic complications[107,108]. This occurs in roughly one-third of IBD patients and increases their likelihood of acquiring a deep venous thrombosis (DVT) postoperatively[107-109]. While NSAIDs are typically contraindicated in these patients due to the preexisting GI damage, heparin and low molecular weight heparin can be safely administered as a DVT prophylactic measure[110].

The higher post-operative failure rates, witnessed in IBD patients undergoing orthopedic procedures, might be explained by the interference of the disease process with osseous integration and subsequent weakening of the implant-integrity area [97]. The chronic inflammatory state associated with the disease, may trigger osteoclasts and osteoblasts, through cytokine-mediated pathways, and possibly affect bone resorbtion [97,111-114]. Nutritional and hormonal deficits might also considerably contribute to these complications[114]. The noticeable increase in GI nutritional losses and decrease in absorptive potential can lead to multiple vitamins, minerals, proteins, and fat deficiencies[115-119]. The predominance of a suboptimal nutritional status among IBD patients might lead to an increase in post-operative infection rate, a decreased wound and bone healing, and eventually affecting surgical outcomes and morbidity[114,120-123].

In addition to the disease process itself, the pharmacologic management of IBD may also contribute to these complications[124]. TNF-α is a macrophage-derived cytokine that mediates inflammation, making it an ideal target in the treatment of autoimmune disorders such as IBD[125]. TNF-α inhibitors are an effective treatment for both CD and UC[126]. They induce remission of the disease, and hence improve quality of life and reduce IBD related hospitalizations[126]. Since TNF-α plays a protective role in the physiologic immune response, patients on TNF-α inhibitors regimen have a higher risk of developing serious and opportunistic infections[127-132]. Some studies have shown no increase in postoperative complication rates in UC or CD patients treated with this class of medications [125]. However, due to the potential increased risk of infections, The Club Rheumatismes et Inflammation (CTI) presented perioperative guidelines for TNF-α inhibitor administration based on the pharmacological half-lives[133]. Etanercept should be discontinued one week prior to surgery, while a duration of four weeks between surgery and the last dose of adalimumab and infliximab is recommended[133]. Since TNF- α inhibitors slow the wound healing process, they should only be resumed after two weeks of appropriate wound healing[134,135].

The treatment with glucocorticoids is a common option for IBD patients[125,136]. However, prolonged use of glucocorticoids compromises the immune system, decreases bone quality, increases the risk of osteonecrosis, and impairs wound healing[137-144]. To avoid the acute adrenal insufficiency associated with the abrupt discontinuation of chronic glucocorticoids treatment, and concurrently minimize the associated postoperative complications, patients should be maintained on a physiologic dose of glucocorticoids and then taper up to preoperative doses following the procedure[125,141,145].

Other notable medications used for IBD treatment are methotrexate (MTX) and azathioprine [125]. MTX administration in the perioperative period is not associated with a higher risk of complications, and hence can be safely continued in IBD patients undergoing surgical procedures[125,146-148]. However, MTX should be withheld 1 week preoperatively and at least 1-2 weeks postoperatively in patients with compromised renal function, due to their higher risks of toxicity[149-151]. Azathioprine and 6-mercaptopurine are widely used as glucocorticoid sparing agents in IBD, with no significant effects on surgical outcomes or morbidity, and thus, can be only held on the day of surgery and resumed within 36 hours as long as renal function is not impaired[125].

Liver Cirrhosis

Cirrhosis of the liver is the result of various chronic liver diseases that start with the damage and necrosis of hepatic cells, causing regenerative nodules which become surrounded by diffuse fibrous bands, leading to portal hypertension and end stage liver disease[8,152]. The prevalence of cirrhosis in the United States is estimated to be 0.15% or 400,000; however, a more reasonable estimate is approximately 1% of the population due to the undiagnosed viral hepatitis and undetected cirrhosis[8]. Chronic viral infections such as the hepatitis B virus (HBV) and hepatitis C virus

(HCV), alongside with excessive alcohol consumption, play the major role in causing cirrhosis [153,154].

With a wide spectrum of metabolic disturbances, liver cirrhosis compromises multiple physiologic processes. The disease is associated with a state of impaired immunity, coagulopathy, malnutrition, and metabolic bone disease[155-161]. With a decreased neutrophil mobilization and phagocytic activity, and lower levels of IgM, IgG, and IgA antibodies, cirrhotic patients have a lower bacterial opsonization capacity and are predisposed to more overwhelming infections [162-164]. Secondary to vitamin D and calcium malabsorption, these patients have a reduced bone mineral density and new bone formation, and hence are more prone to develop osteomalacia and osteoporosis [165]. Thus, screening all cirrhosis patients with bone scans may be necessary to provide insight and prevent further bone disease[161].

Patients with liver cirrhosis are at an increased risk of perioperative complications with high morbidity and mortality rates seen in abdominal and non-abdominal surgeries[166-174]. These patients have an increased rate of bacterial infection that may be due to impaired phagocytic function and other immune deficiencies[160,175,176]. The Child-Turcotte-Pugh (CTP) score has been the standard for assessing operative risks in cirrhosis patients for years, utilizing patient albumin and bilirubin serum levels, pro-thrombin time, and severity of ascites and encephalopathy levels[177,178]. This assessment tool places a patient in a class based on the severity of the cirrhosis with A being lowest and C being most severe[178]. Hsieh et al. reported a 26.7% complication rate in patients with cirrhosis undergoing total hip arthroscopies (THA) [155]. The patients found to be in class B or C of the CTP test were significantly more likely to have complications (52.9%) than those in class A(10.2%)[155]. This study found that advanced age, elevated creatinine, decreased albumin, increased operative blood loss, decreased platelet count, encephalopathy and ascites were associated with a higher perioperative morbidity, consistent with the variables tested with the CTP test[155]. Similarly, total knee arthroplasty (TKA), total hip arthroplasty (THA) and lumbar surgery in class B and C cirrhosis patients were at a significantly higher morbidity, mortality, and complication rates[179-182]. While orthopedic procedures may be safely performed in CTP class A cirrhosis patients, cautious evaluation and determination of potential risks versus benefits of surgical intervention should be sought in those with more severe levels of cirrhosis (B and C).

Conclusion

With high prevalence and incidence rates within the general population, renal and gastrointestinal diseases affect a significant portion of orthopedic patients. The acute and chronic kidney function deteriorations, inflammatory bowel disease and liver cirrhosis impose hemostatic and electrolyte imbalances that require specific management. When clearing those patients for surgical procedures, the outcome-affecting factors related to the disease process itself and the medications implicated in these conditions treatment should be thoroughly evaluated and revisited.

A comprehensive understanding of these conditions and their associated comorbidities will lead to considerable improvements in perioperative medical management and postoperative outcomes. These interventions have the potential to substantially decrease surgery-associated morbidity and mortality.

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