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3. The following quiz questions have been designed to provide a useful link between the CME article in the issue and your everyday practice. Read each question, choose the correct answer, and record your answer on the CME Registration Form at the end of the quiz.
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ABSTRACT

Few guidelines are available to assist orthopedic surgeons in advising patients about when to return to driving after orthopedic surgery. A patient’s surgical procedure, postoperative weight-bearing restrictions, immobilization, and other factors influence a patient’s ability to drive after orthopedic surgery. Multiple studies have used driving simulators to predict when it may be safe to return to driving after orthopedic surgery. However, study conclusions and recommendations vary significantly. This article reviews the factors contributing to a patient’s ability to return to driving after orthopedic surgery and reviews recommendations based on the available literature following fracture, arthroscopy, and arthroplasty.

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Driving After Orthopedic Surgery

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educational objectives

As a result of reading this article, physicians should be able to:

1. Identify preoperative factors that may contribute to a patient’s ability to return to driving after orthopedic surgery.
2. Understand the role of upper-extremity immobilization and how it may impair a patient’s ability to operate a motor vehicle.
3. Recognize how various forms of lower-extremity immobilization (eg, controlled ankle-motion boot, cast, and Aircast Walker) affect braking reaction times and total braking times.
4. Be aware of current guidelines about when it is appropriate to return to driving following arthroscopy, lower-extremity fracture, and hip and knee arthroplasty.
All orthopedic surgeons must consider when to safely allow their patients to resume driving postoperatively. This decision should be made after evaluating multiple factors. A patient’s surgical procedure and postoperative pain level and the effect of analgesic medications and type of postoperative immobilization may all influence a clinician’s decision. Although driving postoperatively is an ubiquitous problem encountered by almost all practicing orthopedic surgeons, no true guidelines exist to help clinicians guide patients to a safe return to postoperative driving.

**Background**

Little is known about the postoperative practices regarding return to driving after orthopedic surgeries. Lewis et al\(^1\) surveyed 100 patients after knee arthroscopy and evaluated their return to driving and the adverse events they experienced while driving within 2 weeks postoperatively. Eighty-five patients had undergone partial meniscectomy, whereas others underwent chondroplasty, microfracture, and diagnostic arthroscopies. Sixty-five percent of survey respondents stated that postoperative driving was addressed by their orthopedic surgeon, and the advice given on how long they were not allowed to drive ranged from 2 days to 4 weeks.\(^1\) This survey highlighted the broad range of advice given by orthopedic surgeons regarding when it may be safe to return to driving following knee arthroscopy. Perhaps more importantly, the authors found that 35% of respondents did not receive any such advice from their orthopedic surgeon.\(^1\)

**Preoperative Concerns**

Numerous factors may contribute to a patient’s ability to safely return to driving following orthopedic surgery. These include the type of surgery, postoperative pain, postoperative weight-bearing restrictions and immobilization, side affected by surgery, baseline driving ability, medical comorbidities, and postoperative stiffness. Orthopedic surgeries are performed for various reasons for the treatment of a broad range of pathologies. In some cases, patients have postoperative weight-bearing restrictions. Lower-extremity unstable or intra-articular fractures and sports medicine procedures, such as meniscal repair, microfracture, and autologous chondrocyte implantation, may require extended periods of nonweight bearing to allow for sufficient fracture or soft tissue healing to occur.\(^2,3\) Weight-bearing restrictions range from nonweight bearing to toe-touch, foot-down, or partial weight bearing. These postoperative limitations may interfere with the need to forcefully press on the brake pedal or accelerator. Prolonged nonweight-bearing protocols also accompany foot and ankle procedures, such as mid- or hindfoot arthrodesis, which make it difficult to apply force to a brake pedal or accelerator.\(^4\) Spinal surgery routinely includes various degrees of arthrodesis, which may significantly limit neck range of motion depending on the level and the extent of the spine affected.

Postoperative pain can be distracting and divert a patient’s full attention from safely operating a motor vehicle. Many commonly prescribed analgesics, especially opioids, have sedative side effects, which can further impair a patient’s ability to drive. The US Food & Drug Administration advises all patients taking opioids not to drive or operate heavy machinery due to drowsiness associated with this class of medications.\(^5\)

Postoperative immobilization and range of motion restrictions also impair a patient’s ability to drive. casts, splints, slings, and knee and elbow immobilizers may limit a patient’s ability to use the affected extremity. With these forms of immobilization, a joint is kept rigid and is difficult to use to drive. The effect of these immobilizers is likely dependent on whether it is placed on the patient’s dominant upper extremity or on the leg. In addition, patients may be able to overcome some forms of immobilization through increasing motion above or below the joints. For example, increased ankle dorsiflexion could help compensate for limited knee flexion in a leg where a knee immobilizer is applied. Regardless, immobilizers may limit a patient’s ability to drive safely.

In many cases, patients may feel confident returning to driving without the use of a nondominant arm or left leg. Patients who drive a vehicle with an automatic transmission do not require the use of their left leg for the clutch pedal, which may make the return to driving safer and quicker in this patient population. Patients may also feel that they can drive using 1 arm while the other is immobilized or following a nonweight-bearing rehabilitation protocol. The patient who is more comfortable or coordinated driving at the baseline may also be able to adapt to immobilization, pain, and other factors that would impair patients who are less confident drivers at baseline. However, driving with 1 upper extremity should be discouraged. In cases where a patient may need to swerve or quickly turn, 1 hand may slip or not have a firm enough grasp on the steering wheel to avert a collision. Manual transmissions and full control of the steering wheel often requires full use of multiple extremities to safely operate a vehicle.

Patients’ medical comorbidities can also influence when it is safe to resume driving. Patients with lower-extremity peripheral vascular disease may take longer to recover from a lower-extremity surgery, and those with peripheral neuropathy may demonstrate decreased lower-extremity control needed for driving. In addition, it may take longer for fractures or surgical incisions to heal in patients with diabetes mellitus or inflammatory modulating diseases, delaying the time to when it is safe to return to driving. Proprioceptive loss associated with peripheral neuropathies from nerve compression or diabetes mellitus may make it difficult for some patients to return to driving with altered sensation in the extremities.
Stiffness is a common complication of many orthopedic surgeries. Adequate composite bending at the wrist, knee, and ankle are physical motions needed to sit in and operate the pedals of a motor vehicle. Steering the wheel is a complicated motion, demanding baseline levels of upper-extremity strength and muscular coordination. In addition, trunk and neck rotation may be needed to safely navigate and survey the area surrounding the vehicle.

Upper-extremity Immobilization

Kalamares et al.\(^6\) surveyed 168 patients from a fracture clinic who had been immobilized in short and long upper-extremity casts. They found that two-thirds of men and one-third of women had driven while immobilized in an upper-extremity cast. In the second part of this study, the senior author underwent driving tests, under the review of a driving instructor while immobilized in long- and short-arm casts. The senior author failed driving tests in long-arm casts but passed driving tests while in a left or right short-arm cast. This study concluded that long-arm casts impair a patient’s ability to operate a vehicle, whereas no such effect was shown in short-arm casts.\(^6\)

Blair et al.\(^7\) investigated 3 types of below-elbow casts and the effect this immobilization had on driving. Healthy volunteers were placed in Colles, Scaphoid, or Bennett’s casts. Volunteers were then graded on several driving abilities, such as gear changing, steering, and driving in reverse. The right Colles cast had no effect on the ability to drive, whereas the Scaphoid and Bennett’s casts were found to significantly impair driving ability. The authors concluded that many factors need to be considered and individually assessed when advising a patient to return to or refrain from driving in a below-elbow cast.\(^7\)

Jazrawi et al.\(^8\) found that immobilization of the dominant arm in a sling may impair a driver’s ability to perform evasive maneuvers when faced with hazardous conditions. In the study, 20 healthy volunteers were tested in a driving simulator with their dominant arm immobilized in a sling. Significantly more collisions in the driving simulator were observed when drivers’ dominant arms were immobilized in a sling. They concluded that although a patient’s dominant arm may not be used under normal driving conditions, hazards may impede an immobilized driver’s ability to safely operate a vehicle.\(^8\)

Lower-extremity Immobilization

The effect of lower extremity immobilization devices on breaking time has been studied. In 1 study, healthy volunteers were divided into 4 groups: no immobilization, a controlled ankle-motion boot, a removable short-leg cast, and a left-foot driving adapter.\(^9\) A left foot driving adapter is a device that allows the left foot to control breaking through a connection with the brake pedal on the right. Volunteers were placed in a driving simulator, and break-response time was measured. Brake response time was significantly lower in the control group than in all other groups. Brake response time was also significantly lower in the left foot driving adapter group than the controlled ankle-motion boot but not significantly different from the short-leg cast. The authors concluded that patients with right lower-extremity immobilization are less impaired in short-leg casts than controlled ankle-motion boots and that the use of a left foot driving adapter may allow patients to return to driving sooner.\(^9\)

Braking times in healthy volunteers immobilized with either a walking cast or an Aircast Walker (Donjoy, Vista, California) have also been evaluated. They were compared with a control group that had no form of immobilization.\(^10\) Braking reaction times and total braking times were assessed with a driving simulator. Braking reaction times and total braking times were significantly shorter in the control group than in the either immobilization group. Total braking time was also significantly shorter in the those wearing a walking cast than in those wearing the Aircast Walker. No significant difference was found in braking reaction time between the walking cast or Aircast Walker groups. The authors concluded that Aircast Walkers significantly impaired driving ability compared with walking casts and that both forms of immobilization had a deleterious effect on operating a vehicle.\(^10\)

Arthroscopy

Several studies have investigated driving safely following arthroscopy procedures. Hau et al.\(^11\) measured driving reaction times in 30 patients who had undergone right knee arthroscopy. Twenty-five healthy volunteers were tested as a control group. Both groups were tested in a computer-linked car simulator preoperatively and 1 and 4 weeks postoperatively. In the arthroscopy group, reaction times at 1 week postoperatively were significantly longer than those measured preoperatively. At 4 weeks postoperatively, reaction times had returned to baseline and were similar to those of the control group. The authors concluded that patients should delay return to driving for at least 1 week following knee arthroscopy.\(^11\)

In another study, brake response times in patients following right anterior cruciate ligament reconstruction were investigated. Patients were assessed at 2, 4, 6, 8, and 10 weeks postoperatively. A control group of 12 healthy volunteers was also used as a control comparison. Brake response times for the anterior cruciate ligament reconstruction group matched the control group after 4 to 6 weeks. The authors concluded that it may be safe for patients to return to driving after an ACL reconstruction by 4 to 6 weeks postoperatively and that measuring brake response times during rehabilitation may be a reliable test to determine when it is safe for a patient to return to driving.\(^12\)

Nguyen et al.\(^13\) prospectively followed driving reaction times in 73 patients before and after anterior cruciate ligament reconstruction. Patients were compared
with a cohort of healthy volunteers and tested at 2, 4, 6, and 8 weeks postoperatively. In patients who had a left anterior cruciate ligament reconstruction, driving reaction time returned to baseline 2 weeks postoperatively; in the right anterior cruciate ligament reconstruction group, driving reaction time returned to baseline at 6 weeks. The authors recommended that patients with a left ACL reconstruction may return to driving as soon as 2 weeks postoperatively, whereas those with a right ACL reconstruction should typically wait 6 weeks.13

**Foot and Ankle Surgery**

Patients undergoing foot and ankle surgery are frequently immobilized or have weight-bearing restrictions postoperatively. Holt et al14 investigated brake response time in a series of patients after first metatarsal osteotomy for the treatment of bunions. All patients had corrective surgery to the right foot and underwent a driving assessment preoperatively and at 2 and 6 weeks postoperatively and then compared them with healthy volunteers. Volunteers were matched for age, driving status, and sex. At 2 weeks postoperatively, 7 of 28 patients were able to complete the driving assessment due to pain. At 6 weeks, all patients were able to complete the driving assessment and had scores comparable to that of healthy individuals. The authors concluded that following first metatarsal osteotomy, pain is a significant barrier to the resumption of driving but that most patients can expect to resume driving by 6 weeks postoperatively.14

**Lower-extremity Fracture**

Egol et al15 assessed braking function in a series of trauma patients following right lower-extremity operative repair. Patients were divided into 2 groups: those with diaphyseal fractures and those with articular fractures, such as tibial plateau, pilon, or acetabulum fractures. Patients were then assessed every 3 weeks postoperatively until 18 weeks and were compared with a cohort of healthy volunteers. The authors found that brake travel time returned to normal at 12 weeks in the diaphyseal fracture group and 18 weeks in the articular fracture group. This was approximately 6 weeks after initiation of weight bearing in each group. They recommended that patients with diaphyseal fractures are able to return to driving an average of 6 weeks before those with articular fractures.15

In another study by the same lead author, patients with right ankle fractures were tested at 6, 9, and 12 weeks after operative repair and were compared with a control group of healthy volunteers. Patients were assessed in a variety of driving scenarios and were tested for total braking time. At each time interval, total breaking time improved and returned to a normal baseline value at 9 weeks.16

**Knee Arthroplasty**

Multiple studies have investigated when it is safe to return to driving following total joint arthroplasty of the knee and hip. Dallury et al17 measured brake response times in a cohort of 29 consecutive patients who underwent right total knee arthroplasty (TKA). Patients were tested using a driving simulator preoperatively and at 4, 6, and 8 weeks postoperatively. Testing was discontinued once a patient returned to preoperative brake response times. They concluded that all patients returned to baseline braking levels 4 weeks postoperatively.17

In another study of patients following right TKA, driver reaction times of 40 patients preoperatively and at 4, 6, 8, and 10 weeks postoperatively were measured. The authors found that the ability to transfer the right foot from the accelerator to the brake pedal did not recover to preoperative levels until 8 weeks after TKA. However, 11 patients in this study did not drive at baseline which may have confounded the results.18

In a prospective study, 31 patients undergoing right TKA had brake response times assessed preoperatively and at 3, 6, and 9 weeks postoperatively. By 6 weeks postoperatively, brake response times had improved an average of 12.5% from the patient’s preoperative baseline. The authors recommended returning to driving 6 weeks after a right TKA. However, 13 of 31 patients in this study underwent bilateral TKA, which may have slowed brake response times in comparison to the unilateral group.19

Marques et al20 assessed return to driving following left TKA in 24 patients. Patients were tested preoperatively and 10 days postoperatively. At 10 days postoperatively, patients had improved in brake response time, reaction time, and movement time compared with preoperative levels. The authors concluded that patients may return to driving as soon as 10 days after a left TKA as long as the patient drives a car with an automatic transmission.20

**Hip Arthroplasty**

Abbas and Waheed followed 130 patients who had undergone a total hip

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*Abbreviations: ACL, anterior cruciate ligament; THA, total hip arthroplasty; TKA, total knee arthroplasty.*
arthroplasty (THA). Eighty-five patients had a right THA and 81 patients drove a car with a manual transmission. Patients were advised to resume driving after 6 weeks if they felt comfortable doing so. They found that 81% of patients were able to resume driving at 6 to 8 weeks after THA. Of those who returned to driving at 6 to 8 weeks, 64% had a right THA and 62% drove a car with a manual transmission. By week 12 postoperatively, 98% of patients had returned to driving. No patients reported a deterioration in driving ability from preoperative levels, and 38% of patients felt a subjective improvement in driving ability.21

Driving reaction time was prospectively evaluated in a cohort of 22 patients before and 8 weeks after THA. This group was compared to 15 healthy volunteers. This study found that 18 of the 21 drivers returned to baseline at 8 weeks postoperatively and found no differences between brake reaction times in patients who had a left THA compared with the control group. The authors concluded that patients who had a left THA may return to driving significantly sooner than those following right THA and that not all patients are ready to return to driving 8 weeks postoperatively. This study recommended using a brake reaction test to assess ability in a patient’s ability to return to driving.22

Ganz et al.23 measured driving reaction times in 100 consecutive patients undergoing right THA preoperatively and at postoperative weeks 1, 6, 26, and 52. All patients had driven regularly within 3 months of surgery, and all used their right foot to brake. In all patients, driving reaction time worsened at 1 week postoperatively. At all other time intervals, reaction time had significantly improved from preoperative levels. The authors concluded that it is safe for patients to return to driving 6 weeks after a right THA and that THA may improve driving ability in patients with advanced osteoarthritis.23

**Limitations to Prior Research Models**

Many studies used to assess when it may be safe to return to driving after orthopedic surgery measure driver reaction time or braking time in a driving simulator. However, this presents several confounding factors to take into account when applying the results from these simulations to real patient care. Driving a vehicle is a complex activity requiring multiple skills to be used at once. Although braking time and driver reaction time are 2 critical skills demonstrated by the competent driver, a driver uses many additional skills that while operating a vehicle, such as the ability to turn a steering wheel or use a clutch pedal in a car with a manual transmission. Studies involving driving simulators are inherently flawed because test subjects may learn the simulators. With enough practice, a volunteer or patient in a study with a driving simulator is likely to improve on their ability to brake or see an unexpected object as a result of practice. This confounds a study’s ability to test such skills in a patient population.

**Legal Concerns**

Significant legal and economic concerns exist when advising a patient about returning to driving. Giddins and Hammerton24 investigated this topic by reviewing laws and driver’s license requirements in the United Kingdom and surveying major automobile insurance companies. They found that drivers in the United Kingdom were covered by insurance if the driver returned to driving following the advice of a doctor.24 Under current English law, a doctor’s professional obligation is to notify authorities if a patient has returned to driving against the doctor’s advice, causing a potential danger to the public.25 Giddins and Hammerton24 concluded that doctors should avoid giving detailed legal advice and not to assume that all patients drive a sedan. Large trucks and motorcycles necessitate different skills from a car and may be held to a different standard.

In the United States, the National Highway Traffic Safety Administration recommends not driving with any splint or immobilization device.26 Although this is a guideline and not law, the American Medical Association has issued a statement that physicians have a responsibility to assess impairments that may affect driving ability and safety.26 However, it should be emphasized that it is the patient’s responsibility to refrain from driving until a level of confidence and comfort has returned that permits safe driving.

**CONCLUSION**

Orthopedic treatment may interfere with a patients’ ability to safely control and operate a motor vehicle. During rehabilitation, it is important to individually assess and guide each patient’s ability to return to driving. This involves a comprehensive evaluation of the patient’s baseline ability, pain level, physical or mobility restrictions, and current ability to operate a vehicle. Although many studies have investigated brake response times and driver reaction times, further research is needed to create realistic and evidence-based guidelines to assist clinicians with the task of safely allowing their patients the autonomy to safely drive after orthopedic surgery or injury. Although orthopedic surgeons may offer recommendations, safe driving after orthopedic surgery is ultimately the patient’s responsibility.

**REFERENCES**


