

**VILNIUS UNIVERSITY
MEDICAL FACULTY**

The Final thesis

Timing of Surgery in Elderly Hip Fracture Patients

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2024

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I. Summary

In elderly patients, the incidence of frailty fractures of the hip joint is increased by osteoporosis and a higher risk of falls. In general, hip fractures need surgical treatment, however, the right timing is crucial, since these fractures have a significant impact on patients' morbidity and mortality.

This review aims to analyze the international literature and national guidelines regarding the optimal point of surgery, taking into account patients' comorbidities as well as the infrastructure and logistics of the hospitals.

Keywords were determined, and a systematic literature search was performed in medical databases. Furthermore, different national guidelines were reviewed, and their recommendations were analyzed.

Most data conclude that surgery should be performed within the first 24 hours after patient's arrival. If comorbidities contradict an early operation, patients' medical conditions should be improved within 48 hours by an interdisciplinary team of trauma surgeons, anesthetists and additional specialists. The same limit is applied if hospital infrastructure is insufficient to perform timely surgery, due to the missing specialist, the needed implant, unavailability of an intensive care bed or multiple emergency operations at the same time.

In conclusion, morbidity and mortality of elderly patients with fractures of the hip joint are significantly affected by the right point of surgery. Patients should be operated on within the first 24 hours, if patient's comorbidities and the clinic infrastructure allow it. Surgery can be postponed up to 48 hours, if needed due to comorbidities or logistics. This conclusion is limited by mostly retro perspective study design and evidence of the literature.

II. Keywords

Hip fracture – hip - femoral neck fracture – pertrochanteric fracture- timing – time to treatment – surgical – early surgery – delay - elderly – anticoagulation – oral anticoagulants – Vitamin K Antagonists – Warfarin – Vitamin K – direct oral anticoagulants– apixaban – rivaroxaban – dabigatran - platelet aggregation inhibitors - Aspirin - acetylsalicylic acid – clopidogrel – dual platelet anticoagulant therapy - prasugrel – ticagrelor – guidelines – American – American academy of orthopaedic surgeons (AAOS) – British – National Institute for Health and Care Excellence (NICE) – German – German association for orthopedic and trauma surgeon (DGOU) – blood loss

– blood transfusion – complications – multidisciplinary – anesthesia - endoprosthesis – osteosynthesis – mortality – morbidity – trauma center – trauma – length of stay – osteoporosis – osteoporotic fracture

III. Introduction

In the last decades, the quality of life in Western society has kept rising. Especially the advancements in the field of medicine have a great impact on the population. Thanks to better patient caretaking life expectancy is increasing. However, with this improvement in healthcare, other challenges arise. While people are getting older their medical record is growing. The result is a more complex treatment planning process, in which benefits and drawbacks need to be considered when providing aid to patients.

In the field of orthopedics, the management of fractures in elderly patients is a daily routine. One type of fracture which is common in clinical practice in this age group is the hip fracture (1,2). In Germany were over 1.000.000 femoral neck fractures between 2005 and 2019. During this time an increase in fractures was recorded (3). Due to the changing demographics an increase of up to five times is expected by 2050 (2). This type of fracture is often due to comorbidities and physical limitations, which humans experience during the process of aging. The pathogenesis of hip fractures in the elderly is mostly due to a low traumatic impact on the hip, like falls (4–6). Those fractures are facilitated due to comorbidities, mainly osteoporosis which weakens the bone structure (7,8). Also, polypharmacy plays a major role (6). Furthermore, conditions such as coordination or vision problems increase the risk of falls (9). Providing medical help for these patients after the injury is crucial. After stabilizing the patient and alleviating the pain, the type of treatment and when it should be performed, need to be considered (9). The main goal is a high survival rate and to minimize the risk for short- and long-term complications as well as reduce functional limitations due to the fracture (9)(p.18).

This review aims to give an overview of the available data about when hip fracture treatment should best be performed in the elderly population. It takes into consideration challenges and problems that might compromise a favorable outcome of timely fracture treatment. So, which kind of comorbidities and healthcare system limitations reduce the chance of a successful, fast-as-possible treatment of fracture? When should an operative intervention be delayed? Therefore, it will be looked at national guidelines from various countries to compare their management strategies. In

the discussion similarities and differences between the different guidelines and studies will be pointed out. Attention will be drawn to obstacles that arise while aiming for fast surgical management of hip fractures.

IV. Material and Methods

4.1 Literature Selection Strategy

The treatment of hip fractures is of great importance, especially in the older population. Therefore, many national institutions formulated guidelines to help doctors manage those fractures in clinical practice. Since these guidelines consist of the results of studies and the expertise of specialists on this topic it is useful to look at their results. For that reason, it was searched for guidelines from different countries, namely Germany together with Austria, the United States, and Great Britain to take their advice into account. In addition, it was looked at literature from orthopedic specialist associations, such as the German Association for Orthopedics and Trauma Surgeons (DGOU). The reason to look especially at the DGOU literature was, that the German and Austrian guidelines are currently being updated and the literature is more recently published.

For new insights and considerations on the surgery timing for individual hip fracture surgery, it was looked at different studies. The search was carried out in PUBMED, Cochrane Library register, and Springer Medicine. Since the guidelines and specialist associations already included the most valuable studies in their guidelines and literature the focus was set on only recent literature published in the last 5 years in the languages English and German.

Table 1 List of Databases searched for literature

Database	Search	Results	Number of literatures left after revision of title and abstract	Last time searched
PubMed	Hip fracture AND timing AND elderly	191	30	25.03.2024
Cochrane library register	Hip fracture AND timing AND elderly	1 Review, 292 Trials	4 trials, 3 lacking results	29.03.2024

Springer Medicine	Schenkelhalsfraktur ODER Hüftfraktur UND Zeitpunkt UND Ältere	40	4	20.03.2024
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One thing that needs to be mentioned is that most studies concerning the timing of hip fracture surgery are observational and therefore retrospective. This lowers the quality of evidence. However, as written in the American guidelines a delay in patient surgery to conduct prospective studies might have negative effects on the patient (5). Therefore, those studies are the best available when considering patients' health outcomes.

Furthermore, hip fracture is a term including different types of fractures at the hip joint. Due to the differences in nature of these fractures, the surgical intervention might also differ. So, keep in mind that different studies also analyze different approaches of management strategies.

Another drawback, also mentioned by the American guidelines, is that most studies with high participant numbers are from bigger trauma centers (5). Those trauma centers might have favorable outcomes when compared to other hospitals. That could be due to a higher frequency of hip fracture patient presentation, better equipment, staffing, and more. So that must be kept in mind when considering the conclusions.

In the more recent studies, there were also some studies included with a lower participant group. The reason for that is to find new ideas and insights on what could alter the time to surgery and when a delay might be the better option. However, those studies do need further research to see if it also applies to a broader subject group.

The Vancouver citation in this review was done with the program Zotero, a project of the Corporation for Digital Scholarship and created by the Roy Rosenzweig Center for History and New Media at George Mason University.

V. Results of Reviewed Literature

5.1 Results of Reviewed Expert Literature

5.1.1 Guidelines - Germany and Austria

The latest guidelines published in Germany, from the Scientific Medical Association Working Group (AWMF), on this topic were about the management of femoral neck fractures in adults. The goal of treatment is said to be: `` [...] [to ensure the survival of the patient, sustain quality of life[...]and] minimize complications and functional limitations after femoral fracture]`` (9)(p.18). Therefore, it says in the guidelines that before the operation the priority is the stabilization of the patient. Treatment with analgesics and assessment of his general condition should be done at the arrival as well as necessary diagnostics. After the situation is stabilized the possibility for surgery and when it should be scheduled is evaluated (9). Not all femoral neck fractures are necessarily treated by surgical intervention. It needs to be assessed individually. A patient with a stable and not dislocated fracture whose pain is manageable might not need to undergo surgery. On the other hand, some patients' medical conditions are unfavorable for a successful surgical intervention, so the risks taken outweigh the benefits (9). However, surgery is usually the treatment of choice (9). The type of surgical procedure needs to be picked according to the circumstances. We have the patient's medical condition that influences the timing and the type of surgery. Therefore, it should be looked at the patient's blood work to check for example electrolytes, blood cells, and coagulation. It can be helpful to work with specialists from other disciplines to evaluate and improve the patient's situation. So, reaching out to a cardiologist if the patient has a cardiac medical history, or working with a geriatrician can be beneficial (9). This interdisciplinary approach can be useful to reduce the complication of, for example, extensive blood loss during and after the operation. This risk might be altered due to the patients' house medication. One example would be anticoagulation therapy. The consequences of pausing those medications can increase the risk of the occurrence of other life-threatening conditions. During the discussion the benefits of a timely surgery need to be considered and whether they outweigh the risks (9). One needs to be aware, that the elderly are often multimorbid and a possible surgical intervention should not be delayed due to health problems that are less urgent in this situation (9).

The patient's initial condition also has an impact on what type of surgery is chosen. While for osteosynthesis the patient in general loses less blood and has a shorter surgery and anesthesia time the long-term outcome concerning mobility and pain is better with a hip replacement (9).

There are factors apart from the patient's medical condition that influence the timing of surgery. The operation time can also be influenced due to logistic factors. Those include the availability of instruments and implants in the hospital, not only for the procedure but also for complications that

might arise perioperative (9). Another logistic factor would be the availability of trained personnel to carry out the specific procedure. This can vary between different institutions (9). If it is necessary reaching out to the patient's supervisor can influence the timing of surgery (9).

The recommendation for the time of operation in the guidelines is as soon as possible after diagnosis. However, the patient's condition needs to be stable enough to undergo a successful operation. For the osteosynthesis procedure, it is recommended within 6-24 hours to reduce the risk of femoral head necrosis. If it is not possible within 24 hours consider puncturing the hemarthrosis. In the case of endoprosthesis, it is also considered best within 24 hours. If the patient is severely ill, he might benefit from a longer preparation time. In those patients, the surgery is recommended to be conducted within 48 hours. The guidelines point out that there is evidence that highly suggests that the delay of surgery for more than 24 hours increases the risk not only for the development of decubitus but also for vein thrombosis and pulmonary embolism. Also, surgical complications increase when waiting before an operation. Another risk that arises with a delayed surgical intervention is an increase in the morbidity and mortality of the patients. When osteosynthesis is the surgery of choice a delay can reduce the chance of a successful osteosynthesis and even have a negative influence on the rehabilitation (9).

5.1.2 Guidelines – United Kingdom

In the United Kingdom, the guidelines from the National Institute for Health and Care Excellence (NICE) concerning hip fracture management were published in 2011. Their latest updates were in 2023. They suggest an immediate pain assessment and stabilization of the patient to be done on arrival at the hospital with routine reassessment (10). After radiological confirmation of the diagnosis of hip fracture, the surgery needs to be timed. They recommend surgery on the day of admission if possible. Otherwise, it should be done on the day after. Before surgery, the patient should be stabilized for the procedure. So, it is important to identify comorbidities that are correctable. If possible, they should be corrected immediately so surgery can be carried out as soon as possible. There is a list of conditions that should be corrected before surgery. This list includes anemia, anticoagulation, volume depletion, electrolyte imbalances, or uncontrolled diabetes. Also, comorbidities affecting the heart function such as uncontrolled heart failure and correctable cardiac arrhythmia, or ischemia are listed. In addition, it should be considered to take care of acute chest diseases or exacerbation of chronic chest conditions (10).

Starting from admission, the patient could benefit from a multidisciplinary approach. Not only for timely optimization of the patient's condition but also for successful surgery. The multidisciplinary approach can also help before and afterward in patient care (10). Especially, when reflecting that most deaths are not due to the fracture itself but to associated conditions, that go along with the high prevalence of comorbidities among hip fracture patients (10).

Another reason, then getting the patient stabilized for surgery is the availability of the theatre team. Therefore, hip fracture surgery should be scheduled in a trauma list. This is to ensure that qualified specialists are there for the surgical intervention or to supervise trainees and junior members (10).

5.1.3 Guidelines – America

The American guidelines were published in 2021 by the American Academy of Orthopaedic Surgeons (AAOS). It focuses on an older population group with an age average of 65 years and a lower limit of 55 years (5). The focus when treating hip fractures in the elderly is to ``[...]provide pain relief and restoration of function`` (5)(p.15). For most hip fractures the benefits of the operation are greater than the harm (5).

Concerning the timing of when surgical treatment should best be conducted, the quality of evidence is considered low due to the available studies, which were considered of low quality. However, they classified the recommendation as moderate. This is mainly because the conduction of randomized control trials can result in a delay in surgical treatment. That could mean harm to the patient and give rise to ethical questions. Regarding pain management, complications as well as the length of hospital stay the available evidence suggested a favorable outcome when the time till surgery is decreased. In general, delay was associated with an increased mortality. However, a patient's comorbidities could alter the favoritism of timely operation. The optimal time varied between 24 hours to 4 days after admission. The majority suggested a timely surgical intervention within 24 to 48 hours. This not only shows a better outcome for the patient but the costs and the use of healthcare resources are also reduced (5).

Since most studies were conducted in well-equipped and experienced centers, that needs to be considered. Sometimes it might not only be useful to delay surgery because of a patient's comorbidities, but also due to factors concerning the hospital. Those factors could be the availability of staffing and specialists of different specialties. Also, the availability of an operation room might delay the time of surgery (5).

5.1.4 German Expert Association

Other than the guidelines, there are more expert associations interested in hip fracture treatment. In 2022 the German Association for Orthopedics and Trauma Surgeons (DGOU) released a book together with the German Association for Geriatrics (DGG) concerning the orthogeriatric management of traumatology in elderly patients. In this book, they give recommendations and criteria for when surgery should be performed and what should be paid attention to in the preoperative phase.

Their named goal in the management of proximal femoral fractures is ``[...]to make an early and pain-free mobilization of the patient possible]``(11)(p.109). They recommend that an operation should also be considered for patients with a non-dislocated hip fracture. The argument is that they are often not able to bear weight only partly on one leg. Furthermore, hip fracture surgery as a method of pain relief should also be considered for bedridden patients (11).

Since the elderly often have more comorbidities, like cognitive and mobility limitations, they should be assessed before an operation. This is to avoid complications during the surgery and for caretaking of the patient. It is advised to assess the patient in a multidisciplinary approach together with geriatrics and anesthesiologists. Emphasis during the preoperative phase should be paid to diseases that can complicate the surgery or can be treated readily(11). The focus should be on organ health. Named diseases are decompensated heart insufficiency or chronic renal insufficiency as well as lung diseases as chronic obstructive diseases. Since dehydration at hospitalization is not uncommon fluid substitutions should be considered. Also, dehydration can be further worsened by blood loss. Checking the electrolytes and correction if necessary as well as renal and anemic improvement are often helpful in the preoperative period. The patient might also profit from the treatment of arrhythmias, infections, and blood sugar fluctuations (11). However, one needs to keep in mind that not all diseases can be treated before the operation and that a delay in surgery might have more disadvantages than treating the comorbidity afterward (11).

In general, they recommend surgery for stable patients within 24 hours after admission. The reason is the increase in mortality and higher complication rate if waited longer. Exceptions to this are patients whose condition cannot be improved within 24 hours. Other would be patients taking anticoagulation medication which cannot be reversed in this time period (11). Anticoagulation can not only influence blood loss, which can be increased peri- and especially intraoperative, but it also

affects the pain treatment. The reason is, that regional anesthesia is usually not performed if a patient is on antithrombotic therapy (11).

Since the effect of anticoagulation medication can persist after stopping the medication or starting the antagonization, the timing of surgery can be influenced. While you can wait a few days in elective surgery, that might not be of benefit for hip fracture patients (11). For each individual patient, a bleeding and thrombosis risk assessment should be done. In this assessment, the patient needs to be asked at what time the anticoagulant was last administered. Consider that even if the bleeding risk is lowered with a delay in surgery, the overall morbidity and mortality do not change for the better. Therefore, the recommendations differ from the waiting period for elective surgery. The advised time to wait before an operation can also differ between anticoagulants. The recommendation for timely surgery can be found in Table 2 (11). Depending on the patient's condition blood cross-matching for eventually necessary blood transfusion should be done (11).

While finding the right timing for the operation there are other factors, which need to be considered, besides the treatment of comorbidities and reversing the anticoagulation. Those include the type of operation chosen, the technique used, and how long it takes (11).

Table 2 Different Anticoagulants and their waiting time (11)(p.75)

Medication	Operation	Specifics
ASA or Clopidogrel, DAPT +ASA & Clopidogrel	No delay	-
Prasugrel or Ticagrelor	24 hours after last administered	-
DOAC	<ul style="list-style-type: none"> - Surgery after 12-24 hours last administered - In exceptions 48 hours 	<ul style="list-style-type: none"> - 48 hours if relevant alteration of renal function and high operative bleeding risk - antagonist available: Idarucizumab (Praxbind) for Dabigatran and Andexanet alfa

		(Ondexxya) for Rivaroxaban and Apixaban (12–15)
Vitamin- K- Antagonist	INR<1,6 operation possible	- INR>1,6 administer PPSB and intervals treatment with Vitamin K

ASA: acetylsalicylic acid, DAPT: Dual antiplatelet therapy, DOAC: direct oral anticoagulant, INR: International normalized ratio, PPSB: prothrombin complex concentrate

5.2 Results of Reviewed Literature and Studies

5.2.1 Delayed surgery

Since the implementation of the 24-48 hours to surgery in the guidelines, various studies have focused on the benefits of this recommendation. In general, earlier surgery shows a reduction in the length of hospital stay (16–18). Due to the shortened hospitalization a reduction in the incidence of pulmonary or urinary tract infections, deep vein thrombosis, and readmission to hospital were observed. Also, a lower risk for a delirium postoperative was seen, when surgery was done timely (17,19). On the other hand, there was no relation found between the timing of surgery and prosthetic joint infection (20). Operation within 48 hours showed in general a reduction in total blood loss and red blood cell transfusion needed (21). However, the effects on mortality are controversial. While there is a probability of higher mortality rates with delayed surgery for more than 48 hours (22–24), some studies did not find a significant connection (16,25,26). This is because mortality and morbidity are found to be influenced by multiple factors. Those include, other than timing of surgery, often patient-related factors like a patient's age and sex and especially various co-morbidities (22,24,26–28).

One study focused on how the age of the patient influences operation timing. So, surgery in patients 80-94 years old should be done preferably within 48 hours. For even older patients, the rise in mortality was not significantly increased with delay in surgery (29). In patients over 90 years with peritrochanteric fracture a higher survival rate was seen with a longer time between admission and surgery (30). However, other studies suggest that older patients might benefit from surgery carried out even within 24 hours if possible (31).

When aiming for the goal of timely surgery intensive preparation of the patient and procedure should not be neglected, because it can increase the possibility of surgical complications (18). Also due to remaining high mortality rates, further research is needed (32).

5.2.2 Type of surgery

While the topic of this review is the timing of surgery it is also important to mention the role of the type of fracture and the surgery used for management of this fracture. The reason is that there are differences in the severity of the procedure. In one study they compared patients with extracapsular fractures treated with osteosynthesis and intramedullary nailing, against intracapsular fractures managed by hip arthroplasty. They found that for intramedullary nailing an intervention within 24 hours after injury was found to have a lower risk of complications. However, the same did not apply to the intracapsular fractures treated by arthroplasty. (33).

5.2.3 Anticoagulation

When talking about the timing of surgery, the complication of bleeding is of major concern. This applies especially to patients taking anticoagulation medications, which is often the case for the elderly. Anticoagulation with direct oral anticoagulation (DOAC) therapy gave rise to new challenges. In addition, Vitamin K antagonists and anti-platelet therapy are of concern. There are various studies concerned with when surgery should be performed on individuals taking anticoagulants. In general, the time to surgery for patients taking anticoagulants is found to be longer (34).

When talking about antiplatelet and dual antiplatelet therapy a surgical delay to increase platelet function seems not beneficial (35,36). On the opposite, it was associated with an increased risk for complications and 30-day mortality (36). Early surgery on the other hand was not only found to have reduced mortality but also a shortened hospital stay (35). If an early operation is associated with an increased transfusion rate differs between the studies (35,36). However, although the bleeding risk might be higher, it seems not to need substantial amounts of blood transfusion (35). There is currently a study that investigates antiplatelet treatment monitoring and utilization for hip fracture patients (37).

Patients taking warfarin at the time of admission have been found to have a delay in surgical treatment, despite the reversing therapy with Vitamin K and four-factor prothrombin complexes.

The mortality and blood loss in this patient group are increased, which seems to be mainly due to the surgical delay, but also because of their comorbidities (38,39). These patients might benefit from a management strategy to decrease the INR and allow faster surgery (38).

When the patient is currently on direct oral anticoagulants (DOAC) the exact timing of surgery seems to be unclear. Although different measurements are possible an exact value when surgery is suggested is not known yet (40,41). While early surgical treatment is said to be possible without an increased risk of blood loss and transfusion needed, a recommended time between the last taken and operation is not given (41–43). However, performing surgery within 48 hours after admission seems possible without increased risk (42-43). One study suggests that operations within 48 hours had no lower mortality rate and should be adjusted for patients (39). Another said, that further delay because of DOAC in individuals waiting for hip fracture surgery is not necessary (41).

Despite the possibility of early surgical intervention in patients taking anticoagulants, they should be prepared in a preoperative setting. It is important to be ready for a possible transfusion that might be needed during the operation (44).

5.2.4 Hospital presentation

While it is often spoken from a timely surgery within 48 hours after admission it often does not include the time between the injury and admission. A prolonged period before hospital arrival can also have negative consequences for a patient. A study during COVID-19 found that patients with hip fractures during the Shelter-In-Place orders were associated with delayed presentation after injury. In addition in those patients, the diagnosis of preoperative deep vein thrombosis was increased (45).

Another study in England, Wales, and Northern Ireland found that there was an effect on timely surgery depending on the time of the patient's presentation. So, the average patient with a hip fracture presented to the hospital in the evening or night was less likely to undergo prompt surgery compared to the daytime presentation. The same was found for patients presenting on Friday or Saturday compared to Thursday (46). A delay in surgery was also seen in a study in the United States because of patient demographics and hospital characteristics (47). Geographic problems in the timing of surgery were also seen in an Australian study. The result suggested that an early transfer to the needed hospital facilities is crucial to reduce the time to surgery (48).

The patients seem to benefit from management programs and interdisciplinary work (49). One example of multidisciplinary assessment can be seen when the patient is prepared for surgery. Before the operation, the patient's risk factors for surgery need to be assessed. Therefore, the scheme of the American Society of Anesthesiologists (ASA) can be used. A higher ASA score is associated with higher perioperative mortality. While surgery for reasons such as aesthetics would not be done if the ASA score is too high this differs in urgent situations. In those the surgeon and the anesthesiologist need to communicate and find a solution (50). For hip fractures, two types of anesthesia are usually used. General anesthesia or spinal anesthesia with or without regional nerve blocks. So, for patients that cannot undergo general anesthesia spinal anesthesia might be an option (51).

VI. Discussion

All guidelines implemented a recommendation for surgery to be done as soon as possible within 24-48 hours (5,9–11). Since then, most clinics have adopted it in their daily practice. This is no surprise considering the available data situation. Despite the limited quality of evidence, pointed out by the American guidelines, due to the observational nature of most studies it seems clear (5). It is agreed that timely surgery is not only associated with benefits for the patient but also for the hospital and health care system. (5,9,10).

6.1 Early surgery – Benefits & mortality rate

The patient benefits from fast pain relief as well as shorter immobilization, which also reduces the risk for complications such as deep vein thrombosis, pulmonary and urinary tract infections, and decubitus (17,19). Furthermore, early surgery was associated with shorter hospitalization (16–18). Shorter hospitalization is also beneficial for the health care system. The patients require fewer resources and less care from the hospital staff (5).

The observed influence of surgery timing on the mortality rate seems to differ. It is often shown that delayed surgery is associated with an increase in mortality (22–24). However, the delay is often due to comorbidities of the patients, which can also influence the chance of successful surgery and rehabilitation (22,24,26–28).

Therefore, an operation as soon as possible within 24-48 hours seems generally like a good solution, but individual patients and their medical history must be taken into account. Especially,

medical conditions and challenges that can be changed in a short time or bear a high risk of surgical complications should be focused on (10,11). Another considerable factor when it comes to the timing of surgery is found in the health care system. It needs to be optimized to allow a fast and efficient supply of resources needed as well as experienced staffing to take care of the patient.

6.2 Anticoagulation

One factor to talk about is ongoing anticoagulation. Often surgery is delayed for patients with anticoagulation medication (34). This is due to the increased blood loss that is feared during and after the operation. However, there are differences between anticoagulants that should be considered. When talking about antiplatelet therapy with acetylsalicylic acid, clopidogrel, or combinations, no necessity for a delay was seen (11,35,36). So, it should not delay the surgical intervention in urgent cases. If the patient is treated with Prasugrel or Ticagrelor the operation should be performed 24 hours after the medication was last taken. Also antagonizing the effect should be considered (11). The effect of Vitamin-K antagonists is possible to be seen by the international normalized ratio (INR), so this should also be performed in practice. A value of INR around $<1,6$ is aimed for. Patients can benefit from a management strategy to achieve this value in a timely manner. In this management strategy, the use of prothrombin complex concentrate (PPSB) and Vitamin K should be considered (11,38).

Direct oral anticoagulation (DOAC) therapy is of special concern. Their use is rising while the possibility of measuring their effect to predict bleeding risk is yet to be found. Their effects remain even after stopping the intake (11,40,41). However, it seems that timely surgery can be done after 12-24 hours. An exception should be made if the renal function is altered. Then a longer waiting period of 48 hours can be beneficial (11,41–43). In addition, there are antidotes available, like Idarucizumab for Dabigatran and Andexanet alfa for Rivaroxaban and Apixaban (14,15). Those should be considered for use in urgent surgery, despite their high costs (2,15).

In general, all patients taking anticoagulants should prior to surgery undergo a risk assessment for their individual bleeding and thrombosis risk. Despite the risk assessment, one needs to consider, that mortality and morbidity are not to be altered positively with a delay in surgery (11,36). Longer waiting times for surgery and antagonization of the anticoagulation therapy can also increase the risk of other vascular events. In addition, it does not decrease the mortality rate (51). So, each

person needs to be assessed individually. However, preparation for possible bleeding complications during surgery should be done for all patients on anticoagulants (11,44).

6.3 Comorbidities & multidisciplinary work

The NICE guidelines mentioned specific conditions that should be corrected. The focus should be on conditions that can be changed in time (10). Other than anticoagulation those correctable conditions include dehydration and electrolyte as well as blood sugar disturbances. Especially in older patients' dehydration is common. This can be worsened due to the blood loss caused by fractures. They can benefit from fluid infusions or even blood transfusions. Also correcting electrolyte imbalances and blood sugar can be helpful to minimize complications. If possible, other changeable conditions involving organ function like arrhythmia should also be taken care of (10,11).

While guideline recommendations are for a general population, patients in different age groups and health statuses can benefit from different timing strategies. For patients who are in general without many comorbidities a timely surgery on the day of arrival or at least within 24 hours seems the best. The complication rate is expected to be low, and the immobilization time is kept short. That ensures the risk, associated with a longer immobilization, to be lower and a faster pain relief (11,16–18). Elderly with many comorbidities can benefit from a timely surgery, to reduce negative influences from immobilization as well. On the other hand, preparation for surgery might lower their risk for complications during and afterward. For this type of patient, it is emphasized by all guidelines that a multidisciplinary approach is useful (5,9–11). This can help to assess the different benefits and risks for this individual person with his comorbidities. Through the different perspectives of orthopedics, radiologists, anesthesiologists, geriatricians, and other needed specialists it can be ensured to find the best possible management approach available for every individual patient. It is best if there is a structure for interdisciplinary assessment of the patient on arrival in the emergency room. Also, the benefits and disadvantages of different kinds of anesthesia, general and spinal, should be discussed between the specialists and with the patient to find a solution. If the patient has a caretaker, it should be reached out to him in time, to involve him (9).

6.4 Type of surgery

Other than a patient's comorbidities, the type of surgery needed for the different kinds of hip fractures should be considered. This was highlighted by the German guidelines, due to differences

between the treatment options (9). Generally, osteosynthesis has a lower bleeding risk and could be done earlier. Hip replacement has mostly a longer operation and therefore anesthesia time, which is a higher burden for the patient. So because of its characteristics, osteosynthesis could also be considered for pain relief in bedridden patients, who do not need full mobility function (11,33). On the other hand, arthroplasty often has better long-term functional results, especially for older active people (9). It is easier for earlier mobilization and weight bearing as osteosynthesis (9). So, a larger proportion of people are managed with hip replacements (3). The skills of the operating surgeon might also influence the treatment performed.

Elderly patients with stable and not dislocated fractures should also be considered for surgical treatment (11). This is due to the fact that the elderly often cannot do partial weight bearing. This can result in a dislocation later or a longer patient immobilization due to pain. This would increase the risk of immobilization-associated diseases (11).

6.5 Healthcare system

Other factors influencing the delay of surgery, despite the patient-related, are hospital factors. Those were especially mentioned by the guidelines from Germany and the United Kingdom. It is not only the time of admission that plays a role in timely surgery (45). The availability of trained staff is also important to carry out necessary interventions. The needed resources such as implants and instruments for the special procedures and management of complications and comorbidities are necessary as well. Access to the needed facilities like the operation room is also important (5,9,10). In trauma centers, the availability of the required resources and infrastructure for trauma patients is more advanced than in smaller hospitals. So, leading patients, if possible, to the trauma center can benefit them (5,48). However, surgery should not be delayed due to transferring patients as long as the transferring clinic has everything available that is needed.

Although the patient's health is of utmost importance also financial benefits in the timing of surgery need to be addressed. As stated by the American guidelines timely surgery is associated with less cost. This is due to shorter hospital stays. Furthermore, the patient needs less resources and caretaking (5).

VII. Conclusion

In conclusion, guidelines and literature recommend surgery as soon as possible within 24 hours after a patient's arrival. If comorbidities, medication taken, or health care limitations contradict an early surgery, operation should be performed within 48 hours. The preoperative assessment of the patient's fracture and comorbidities should be done in a trauma center by an interdisciplinary team with trauma surgeons, anesthesiologists, radiologists and further needed specialists to find the best individual treatment algorithm. In this assessment, focus should be on the patient's individual surgical relevant and changeable factors, opposing successful timely surgery. The type of surgery, osteosynthesis or hip arthroplasty, must be discussed. Furthermore, the type of anesthesia, general versus spinal, and its perioperative benefits must be assessed.

Guidelines, therapy programs and multidisciplinary approaches are essential parameters to ensure the best possible outcome for elderly hip fracture patients. Comorbidities and healthcare-associated factors are relevant too. Although the aim is surgery as soon as possible within 24 hours, it might be postponed up to 48 hours, if these factors can be significantly improved.

VIII. References

1. Jäger M, Portegys E, Busch A, Wegner A. Schenkelhalsfrakturen. Orthop. 2023 Apr 1;52(4):332–46.
2. Koehl P, Pelk K, Necula R, Goyal T, Abbas K, Schuh A. springermedizin.de. 2022 [cited 2024 Mar 26]. Hüftgelenksnahe Frakturen im Alter. Available from: <https://www.springermedizin.de/schenkelhalsfrakturen/femurfrakturen/hueftgelenksnahe-frakturen-im-alter/23346340?searchResult=24.Schenkelhalsfraktur%20UND%20Zeitpunkt%20ODER%20H%C3%BCftfraktur%20UND%20%C3%84ltere&searchBackButton=true&fulltextView=true>
3. Stratos I, Eidmann A, Eisert M, Horas K, Rudert M. Deutsches Ärzteblatt. 2022 [cited 2024 Mar 19]. Endoprothetische Versorgung von Schenkelhalsfrakturen in Deutschland. Available from: <https://www.aerzteblatt.de/archiv/226493/Endoprothetische-Versorgung-von-Schenkelhalsfrakturen-in-Deutschland>
4. Parkkari J, Kannus P, Palvanen M, Natri A, Vainio J, Aho H, et al. Majority of Hip Fractures Occur as a Result of a Fall and Impact on the Greater Trochanter of the Femur: A Prospective Controlled Hip Fracture Study with 206 Consecutive Patients. Calcif Tissue Int. 1999 Sep 1;65(3):183–7.
5. American academy of orthopaedic surgeons Management of Hip Fractures in Older Adults Evidence-Based Clinical Practice Guideline hipfxcp.pdf [Internet]. [cited 2024 Mar 20]. Available from: <https://www.aaos.org/globalassets/quality-and-practice-resources/hip-fractures-in-the-elderly/hipfxcp.pdf>;2021 Dec 3:14-15,25
6. Fleischhacker E, Gleich J, Hesse E, Bücking B, Liener UC, Neuerburg C. springermedizin.de. 2021 [cited 2024 Mar 26]. Individuelle Besonderheiten bei hochbetagten Patienten mit Fragilitätsfrakturen. Available from: <https://www.springermedizin.de/computertomografie/magnetresonanztomografie/individuelle->

besonderheiten-bei-hochbetagten-patienten-mit-
fragi/19861232?searchResult=29.Schenkelhalsfraktur%20UND%20Zeitpunkt%20ODER%20H%C3%BC
ftfraktur%20UND%20%C3%84ltere&searchBackButton=true

7. Wirth CJ, Mutschler W, Kohn D, Pohlemann Ti. Praxis der Orthopädie und Unfallchirurgie; Altersorthopädie und -traumatologie; Osteoporose- der „silent killer“. 3rd ed. Stuttgart: Georg Thieme Verlag; 2014. 222–223 p.
8. Bartl R. Klinische Osteologie: Entstehung, Diagnostik, Prävention und Therapie aller Knochenerkrankungen; Versorgung von osteoporotischen Frakturen; Proximale Femurfrakturen. Stuttgart: Georg Thieme Verlag; 2014. 136–137 p.
9. Weber A, Bonnaire F. S2e-Leitlinie 012/001: Schenkelhalsfraktur des Erwachsenen. AWMF Online. 2015 Oct 9;8–26.
10. NICE guideline Hip fracture management.pdf [Internet]. [cited 2024 Mar 20]. Available from: <https://www.nice.org.uk/guidance/cg124/resources/hip-fracture-management-pdf-35109449902789>, last updated 2023 Jan 6:5-11,22.
11. Liener UC, Becker C, Rapp K, Raschke MJ, Kladny B, Wirtz DC, et al., editors. Weißbuch Alterstraumatologie und Orthogeriatric. 1. Auflage. Stuttgart: Verlag W. Kohlhammer; 2022. 65-85,109 p.
12. Ondexxya | European Medicines Agency [Internet]. [cited 2024 Mar 29]. Available from: <https://www.ema.europa.eu/en/medicines/human/EPAR/ondexxya>
13. Praxbind | European Medicines Agency [Internet]. [cited 2024 Mar 29]. Available from: <https://www.ema.europa.eu/en/medicines/human/EPAR/praxbind>
14. Herold G, Beckers H, Lehmann K. Innere Medizin. Köln; 2024. 836 p.
15. Herdegen T. Kurzlehrbuch Pharmakologie und Toxicologie. 4th ed. Stuttgart: Georg Thieme Verlag; 2020. 168–169 p.
16. Sermon A, Rochus I, Smeets B, Metsemakers WJ, Misselyn D, Nijs S, et al. The implementation of a clinical pathway enhancing early surgery for geriatric hip fractures: how to maintain a success story? Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc. 2019 Apr;45(2):199–205.
17. Sun L, Wang C, Zhang M, Li X, Zhao B. The Surgical Timing and Prognoses of Elderly Patients with Hip Fractures: A Retrospective Analysis. Clin Interv Aging. 2023 Jun 2;18:891–9.
18. Saul D, Riekenberg J, Ammon JC, Hoffmann DB, Sehmisch S. Hip Fractures: Therapy, Timing, and Complication Spectrum. Orthop Surg. 2019 Sep 30;11(6):994–1002.
19. Oberhofer E. springermedizin.de. 2020 [cited 2024 Mar 26]. Was bringt die Turbo-Op. nach Hüftfraktur? Available from: <https://www.springermedizin.de/schenkelhalsfrakturen/osteosynthese/was-bringt-die-turbo-op--nach-hueftfraktur-/17692564?searchResult=7.Schenkelhalsfraktur%20UND%20Zeitpunkt%20ODER%20H%C3%BCftfraktur%20UND%20%C3%84ltere&searchBackButton=true>
20. Horner NS, Grønhaug Larsen KM, Svantesson E, Samuelsson K, Ayeni OR, Gjertsen JE, et al. Timing of hip hemiarthroplasty and the influence on prosthetic joint infection. PLoS ONE. 2020 Mar 12;15(3):e0229947.

21. Su S, Zhang Y, Wang R, Zhou R, Chen Z, Zhou F. Early surgery within 48 h was associated with reduced perioperative blood loss and red blood cell transfusion requirements in older patients with hip fracture: a retrospective study. *Eur Geriatr Med.* 2023 Dec;14(6):1241–8.
22. Yaacobi E, Marom O, Gutman N, Zabarqa S, Brin Y, Ohana N. Mortality following surgery for geriatric hip fractures: is it the timing or the co-morbidities? *Hip Int J Clin Exp Res Hip Pathol Ther.* 2022 Mar;32(2):271–5.
23. Danford NC, Logue TC, Boddapati V, Anderson MJJ, Anderson FL, Rosenwasser MP. Debate Update: Surgery After 48 Hours of Admission for Geriatric Hip Fracture Patients Is Associated With Increase in Mortality and Complication Rate: A Study of 27,058 Patients Using the National Trauma Data Bank. *J Orthop Trauma.* 2021 Oct 1;35(10):535–41.
24. Beaupre LA, Khong H, Smith C, Kang S, Evens L, Jaiswal PK, et al. The impact of time to surgery after hip fracture on mortality at 30- and 90-days: Does a single benchmark apply to all? *Injury.* 2019 Apr;50(4):950–5.
25. Turesson E, Ivarsson K, Thorngren KG, Hommel A. The impact of care process development and comorbidity on time to surgery, mortality rate and functional outcome for hip fracture patients: a retrospective analysis over 19 years with data from the Swedish National Registry for hip fracture patients, RIKSHÖFT. *BMC Musculoskelet Disord.* 2019 Dec 26;20(1):616.
26. Postler A, Posten C, Schubert M, Beyer F, Lütznier J, Vicent O, et al. Patients risk for mortality at 90 days after proximal femur fracture - a retrospective study in a tertiary care hospital. *BMC Geriatr.* 2024 Feb 3;24(1):130.
27. Liu Z, Du Z, Lu H, Fu Z, Xu H. Delay between admission and surgery as a potential risk factor for postoperative morbidity and mortality in elderly patients with hip fractures: A retrospective study. *J Orthop Sci Off J Jpn Orthop Assoc.* 2023 Sep;28(5):1124–30.
28. Kanthasamy S, To K, Webb JI, Elbashir M, Parker MJ. Timing of surgery for internal fixation of intracapsular hip fractures and complications at 1 year; a 32 year clinical study of 2,366 patients at a single center. *Injury.* 2022 Feb;53(2):584–9.
29. Schermann H, Ashkenazi I, Graif N, Ogawa T, Morgan S, Ben Tov T, et al. Would giving priority in surgery timing to the oldest patients result in lower mortality? *Int Orthop.* 2022 Aug;46(8):1701–6.
30. Ghanem M, Garthmann J, Redecker A, Ahrberg-Spiegl AB, Fakler JKM, Spiegl UJA. Management of pertrochanteric fractures in patients over 90 years: In-hospital mortality rate, complications and associated risk factors. *BMC Musculoskelet Disord.* 2021 Sep 16;22(1):799.
31. Seckel T, Mahoney K, Hewitt C, Liu H, Ang D. Outcomes After Definitive Surgery for Nonagenarians with Isolated Hip Fractures within 24 hours of Admission. *Am Surg.* 2023 May;89(5):1821–8.
32. Klopfer T, Hemmann P, Schreiner AJ, Bahrs C. *springermedizin.de.* 2019 [cited 2024 Mar 26]. Proximale Femurfraktur. Available from: <https://www.springermedizin.de/femurfrakturen/schenkelhalsfrakturen/proximale-femurfraktur/16745132?searchResult=38.Schenkelhalsfraktur%20UND%20Zeitpunkt%20ODER%20H%C3%BCftfraktur%20UND%20%C3%84ltere&searchBackButton=true&fulltextView=true>

33. Daginnus A, Schmitt J, Graw JA, Soost C, Burchard R. Rate of Complications after Hip Fractures Caused by Prolonged Time-to-Surgery Depends on the Patient's Individual Type of Fracture and Its Treatment. *J Pers Med*. 2023 Oct 8;13(10):1470.
34. Farhan-Alanie MM, Chinweze R, Walker R, Eardley WGP, HASTE collaborators. The impact of anticoagulant medications on fragility femur fracture care: The hip and femoral fracture anticoagulation surgical timing evaluation (HASTE) study. *Injury*. 2024 Feb 27;55(6):111451.
35. Yang Z, Ni J, Long Z, Kuang L, Gao Y, Tao S. Is hip fracture surgery safe for patients on antiplatelet drugs and is it necessary to delay surgery? A systematic review and meta-analysis. *J Orthop Surg*. 2020 Mar 12;15(1):105.
36. Tarrant SM, Kim RG, McGregor KL, Palazzi K, Attia J, Balogh ZJ. Dual Antiplatelet Therapy and Surgical Timing in Geriatric Hip Fracture. *J Orthop Trauma*. 2020 Oct;34(10):559.
37. Second Affiliated Hospital, School of Medicine, Zhejiang University. Safety and Effectiveness of Clopidogrel Withdrawal Time Guided by Thromboelastography in Elderly Patients With Hip Fracture [Internet]. clinicaltrials.gov; 2019 Nov [cited 2024 Jan 1]. Report No.: NCT04165538. Available from: <https://clinicaltrials.gov/study/NCT04165538>
38. Caruso G, Andreotti M, Marko T, Tonon F, Corradi N, Rizzato D, et al. The impact of warfarin on operative delay and 1-year mortality in elderly patients with hip fracture: a retrospective observational study. *J Orthop Surg*. 2019 Jun 4;14(1):169.
39. Shani M, Yahalom R, Comaneshter D, Holtzman K, Blickstein D, Cohen A, et al. Should patients treated with oral anti-coagulants be operated on within 48 h of hip fracture? *J Thromb Thrombolysis*. 2021 May;51(4):1132–7.
40. Dunois C. Laboratory Monitoring of Direct Oral Anticoagulants (DOACs). *Biomedicines*. 2021 Apr 21;9(5):445.
41. Tarrant SM, Catanach MJ, Sarrami M, Clapham M, Attia J, Balogh ZJ. Direct Oral Anticoagulants and Timing of Hip Fracture Surgery. *J Clin Med*. 2020 Jul 12;9(7):2200.
42. Wang J, Nilssen P, Stone J, Breda K, Little M, Moon C, et al. Expedited surgery does not increase transfusion rates for patients with geriatric hip fracture taking factor Xa inhibitors. *OTA Int Open Access J Orthop Trauma*. 2023 Dec;6(5 Suppl):e292.
43. Abane C, Gominard P, Hardy J, Alain A, Marcheix PS. Should recommended laboratory-test cut-offs allowing surgery be followed for proximal femoral fractures in patients on direct oral anticoagulant therapy? *Orthop Traumatol Surg Res OTSR*. 2024 Jan 24;103819.
44. Schuetze K, Eickhoff A, Dehner C, Gebhard F, Richter PH. Impact of oral anticoagulation on proximal femur fractures treated within 24 h - A retrospective chart review. *Injury*. 2019 Nov;50(11):2040–4.
45. Wang J, Breda K, Moon CN, Little MTM, Lin CA. COVID-19 Shelter-In-Place Orders Associated With Delayed Presentation and Deep Venous Thrombosis in Geriatric Hip Fractures. *Orthopedics*. 2021;44(4):223–8.
46. Shah A, Matharu GS, Inman D, Fagan E, Johansen A, Judge A. Variation in timely surgery for hip fracture by day and time of presentation: a nationwide prospective cohort study from the National Hip Fracture Database for England, Wales and Northern Ireland. *BMJ Qual Saf*. 2021 Jul;30(7):559–66.

47. Bhatti UF, Shah AA, Williams AM, Biesterveld BE, Okafor C, Ilahi ON, et al. Delay in Hip Fracture Repair in the Elderly: A Missed Opportunity Towards Achieving Better Outcomes. *J Surg Res.* 2021 Oct 1;266:142–7.
48. Butler SA, Salipas A, van der Rijt A. Comparative study of outcomes for elderly hip fractures presenting directly to a referral hospital versus those transferred from peripheral centres. *ANZ J Surg.* 2019 Oct;89(10):1314–8.
49. Dreinhöfer K. *Deutsches Ärzteblatt.* 2020 [cited 2024 Mar 3]. Ältere mit Hüftfraktur: Zeit zu handeln. Available from: <https://www.aerzteblatt.de/archiv/212052/Aeltere-mit-Hueftfraktur-Zeit-zu-handeln>
50. Roewer N, Thiel H. *Taschenatlas Anästhesie.* 6th ed. Stuttgart: Georg Thieme Verlag; 2017. 44 p.
51. Griffiths R, Babu S, Dixon P, Freeman N, Hurford D, Kelleher E, et al. Guideline for the management of hip fractures 2020. *Anaesthesia.* 2021;76(2):225–37.