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TREATMENT STRATEGY FOR ELDERLY AND SENILE PATIENTS WITH FEMORAL FRACTURES

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✓ ***Resume***

The use of the developed treatment and diagnostic algorithm reduced the incidence of peri-implant resorption by more than twofold, secondary fixation instability by 3.1 times, migration of fixation elements by 4.2 times, mechanical failure of osteosynthesis by more than fourfold, the incidence of delayed consolidation from 53.5% to 24.4%, and fracture nonunion from 18.6% to 4.4%. The algorithm also reduced the time it took for callus formation and restoration of weight-bearing capacity, while improving patients' quality of life.

Keywords: femur, fracture, elderly and senile patients, algorithm.

СТРАТЕГИЯ ЛЕЧЕНИЯ БОЛЬНЫХ ПОЖИЛОГО И СТАРЧЕСКОГО ВОЗРАСТА ПРИ ПЕРЕЛОМАХ БЕДРЕННОЙ КОСТИ

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✓ ***Резюме***

Применение разработанного лечебно-диагностического алгоритма снизило частоту периимплантной резорбции более чем в 2 раза, вторичную нестабильность фиксации - в 3,1 раза, миграцию фиксирующих элементов - в 4,2 раза, механическую несостоятельность остеосинтеза - более чем в 4 раза, уменьшение частоты замедленной консолидации с 53,5% до 24,4% и несращение перелома с 18,6% до 4,4%, а также сокращением сроков формирования костной мозоли и восстановления опороспособности на фоне улучшения качества жизни пациентов.

Ключевые слова: бедренная кость, перелом, пожилой и старческий возраст, алгоритм.

KEKSA VA QARI YOSHDAGI BEMORLAR SON SUYAGI SINISHLARIDA DAVOLASH STRATEGIYASI

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✓ ***Rezyume***

Ishlab chiqilgan davolash va diagnostika algoritmidan foydalanish peri-implant rezorbsiyasi chastotasini 2 martadan ko'proqqa, fiksatsiyaning ikkilamchi beqarorligini 3,1 martaga, fiksatsiya elementlarining migratsiyasini 4,2 martaga, osteosintezning mexanik ishdan chiqishini 4 martadan ko'proqqa, kechiktirilgan konsolidatsiya chastotasini 53,5% dan 24,4% gacha va sinishlarning birlashmasligini 18,6% dan 4,4% gacha kamaytirishga, shuningdek, bemorlarning hayot sifatining yaxshilanishi fonida suyak kallusining shakllanish vaqtining qisqarishiga va og'irlik ko'tarish qobiliyatining tiklanishiga olib keldi.

Kalit so'zlar: son suyagi, sinishlar, keksa va qari yosh, algoritm.

Relevance

Research is ongoing worldwide to study age-associated factors in impaired bone consolidation in CI fractures and the mechanisms underlying delayed consolidation in patients with CI. Current understanding suggests that osteoporosis, decreased cortical bone quality, multifragmentary fractures, impaired interfragmentary interactions, and deterioration in the stability of the bone-fixator system play a key role in the development of an unfavorable course of the reparative process. Several researchers have found that fracture morphology, the degree of translational displacement, and repositioning characteristics directly influence the likelihood of delayed bone consolidation (1, 3, 5, 7). The literature also highlights the importance of fragility syndrome, comorbid conditions, and age-related somatic maladaptation as factors in unfavorable postoperative outcomes in patients with CI fractures (9, 10). Despite accumulated data, the contribution of clinical and immunological interactions to the development of mechanical decompensation of the bone-fixator system in CI fractures in patients with SI remains poorly understood (2, 4, 6, 8).

Study objective: to develop a risk-based treatment and diagnostic algorithm and a modified osteosynthesis method for femur fractures in elderly and senile patients.

Materials and Methods

The outcomes of 88 elderly and senile patients with CI fractures who underwent surgical treatment with various osteosynthesis methods were analyzed. The patients were divided into a control group (43 patients) using a traditional treatment approach and a study group (45 patients) using the developed risk-based LDA for predicting and preventing delayed CCT in CI fractures.

Results and discussion

For patients with a "low-risk" prognosis, according to the conditions of the LDA we developed, standard surgical osteosynthesis tactics are prescribed based on the location and morphology of the fracture. This could, in principle, justify and allow for its use even in district medical centers and district branches of emergency centers. However, even among patients with this risk level, we took into account the age-associated risk of impaired bone remodeling. Therefore, we administer prophylactic antiresorptive support to all patients. Zoledronic acid, a single dose of 5 mg intravenously, is used as the baseline drug after stabilization of the patient's general condition and correction of fluid and electrolyte balance. We chose this drug due to its ability to suppress excessive osteoclastic activity and reduce the severity of peri-implant resorption without the need for long-term daily administration. Additionally, calcium supplements were prescribed at a dose of 1000-1200 mg/day and vitamin D3 at a dose of 800-1000 IU/day after decompensated renal disease was ruled out. Postoperative care should be carried out according to the standard protocol of early mobilization and routine radiographic monitoring.

When a patient was diagnosed with a "high risk" prognosis, our LDA already included a more active preventative tactic. The most significant problems in this category of patients with PSS were not so much related to technically correct osteosynthesis, but rather to the fact that this result began to function in conditions of reduced bone quality itself, accompanied by pronounced inflammatory-resorptive activation. Therefore, therapeutic intervention should be focused on simultaneously influencing two different mechanisms. The first mechanism was justified by the need for preventive peri-implant bone resorption, and the second mechanism should be aimed at enhancing the local mechanical stability of the fixation zone itself. Moreover, we began antiresorptive support preoperatively, when, after assessing the patient's renal function and calcium levels, we began administering zoledronic acid at a single dose of 5 mg intravenously. Postoperatively, therapy continued under dynamic clinical and radiographic monitoring with repeated assessment of signs of risk of consolidation failure. Continuous correction of calcium and vitamin D deficiency was also performed.

For patients with a "critical risk" prognosis, we developed an LDA, which, according to its conditions, no longer focused on prevention in the broad sense, but on a more targeted intervention to reduce the likelihood of mechanical decompensation of the osteosynthesis being performed. Patients in this prognostic risk category exhibited a combination of pronounced inflammatory-resorptive activation, decreased long-bone quality, and a high probability of fixation instability with standard

surgical tactics. Therefore, the primary objective was to create a maximally stable fixation system capable of maintaining functional stability under conditions of adverse remodeling. Moreover, we initiated antiresorptive therapy (zoledronic acid) preoperatively and continued it throughout the postoperative period under dynamic monitoring using the CONSOLID scale. After the initial administration of zoledronic acid, we administered prolonged calcium and vitamin D supplementation, with mandatory monitoring for signs of peri-implant resorption and secondary fixation instability. If the "high risk" of consolidation impairment persisted, treatment was continued until clinical and radiographic signs of stabilization of the reparative process were achieved. Therefore, surgical tactics for this risk category were geared toward modifying standard osteosynthesis, prioritizing mechanical reliability over minimal invasiveness. For proximal CT fractures, we used long cephalomedullary structures with mandatory enhancement of rotational stability and expansion of the fixation zone. For diaphyseal fractures, we preferred extending the fixation length with additional locking elements. At the same time, combined bridge stabilization with prolonged unloading of the segment has become the main method for operations on fractures of the distal parts of the ligament in patients with PFS.

Before conducting a comparative evaluation of the effectiveness of the LDA we developed for CT fractures in patients with PFS, we considered it appropriate to provide preliminary information regarding the baseline immunoinflammatory status in both the control and study groups.

Our comparison of baseline immunological values revealed no statistically significant differences between patients in the control and study groups at admission and before the start of treatment. This comparison was crucial because it allowed us to exclude the influence of baseline immunoinflammatory imbalance as an independent cause of possible differences in subsequent treatment outcomes. Furthermore, we believe that comparing the baseline risk levels was also crucial for the comparison. Furthermore, in the control group, we assigned patients by risk level retrospectively based on an analysis of baseline clinical, traumatological, and immunological data obtained upon admission. This means that we assessed their risk after completion of standard treatment and analysis of the actual outcome of the CCT. As for the main group, we had already prospectively stratified them by risk level, that is, during the implementation of the CONSOLID scale, directly during the initial patient examination, before selecting a treatment strategy.

As a result, the data we obtained allowed us to use these predictive results as a basis for further risk-based treatment modification.

Among patients in the control group, the distribution of patients by risk level for an unfavorable outcome of the CCT was generally relatively balanced. In fact, one-third of patients belonged to one of the risk categories. In the main group, a similar balance was different, and it was characterized by a relatively large number of patients with a "high" risk of CCT violation, exceeding the values of the control group by 7.4%, but did not reach a statistical difference ($\chi2 = 0.520$; $p = 0.471$), and in other cases, the frequency of patients among patients in the main group was less than in the control group, but these changes did not have statistical significance in the difference, which, however, was to be expected when comparing patients with the same sampling conditions.

It can be stated in more detail that during a retrospective assessment of patients in the control group, where the "low predicted risk" of CCT violation was identified in 13/43 (30.2%) patients, and in the main group this risk category was determined in 11/45 (24.4%) patients ($\chi2 = 0.371$; $p = 0.542$); "High predicted risk" of impaired CCT in CT fracture in patients with PSF in the control group was determined in 14/43 (32.6%) patients, while in the main group it was determined in 18/45 (40.0%) patients ($\chi2=0.520$; $p=0.471$); "critical predicted risk" of impaired consolidation was retrospectively determined in 16/43 (37.2%) patients in the control group and in 16/45 (35.6%) patients in the main group ($\chi2=0.025$; $p=0.874$).

Based on the results of this comparison, it should be noted that in the control group, the retrospective risk assessment did not always completely coincide with the actual treatment outcome, among which some patients classified as "high risk" subsequently showed signs of incompetent CCT and secondary mechanical decompensation of osteosynthesis.

The incidence of peri-implant resorption in the control group reached 46.5% (20/43 patients), while in the study group this indicator decreased more than 2-fold (9/45 patients; 20.0%) with a statistically significant difference ($\chi2=6.89$; $p=0.009$). We believe that this was due to the use of zoledronic acid, correction of calcium-phosphorus metabolism, and limiting early overload of the fixation zone, which

together allowed us to reduce the severity of resorptive remodeling around the fixation elements. Also noteworthy is the additional use of enhanced local mechanical support in patients with high and critical risks, including the very same technique of cement augmentation with extended fixation described by us, which reduced the likelihood of progressive destruction of peri-implant bone tissue. The incidence of secondary instability in patients in the study group decreased, which was one of the most significant results, since the gradual loss of structural stability was the central mechanism for the transition of delayed CCT to mechanically incompetent consolidation. This disappointing result was observed in 15/43 (34.9%) patients in the control group, whereas the use of the LDA developed by us among patients in the study group resulted in a 3.1-fold decrease in this outcome, demonstrating statistical significance (5/45 patients; 11.1%; $\chi2=7.14$; $p=0.008$). Furthermore, migration of the fixing element among patients in the main group, due to the use of long cephalomedullary systems with an additional anti-rotation element, and in the presence of signs of severe osteoporotic remodeling, cement augmentation of the proximal fixing component, allowed for a more stable load distribution and reduced the risk of gradual migration of the structure, which among patients in the control group was observed in 8/43 (18.6%) patients, while in the main group this indicator decreased by 4.2 times, dropping to a frequency of 4.4% (2/45 observations; $\chi2=4.41$; $p=0.036$).

In the control group, varus deformity of the segment developed in 10/43 (23.3%) patients, while in the main group this indicator decreased to 6.7% and was observed only in 3/45 patients ($\chi2=4.87$; $p=0.027$), and signs of mechanical failure of fixation among patients in the main group decreased 4 times more often compared to the control group ($\chi2=8.61$; $p=0.003$). We were able to reduce the cases with the need for repeated surgical interventions among patients in the main group by 3.8 times, achieving a reliable difference between the groups ($\chi2=5.89$; $p=0.015$). For patients with PSV, the reduction in the frequency of revision surgeries had not only surgical but also general clinical significance, especially when repeated surgeries can contribute to deterioration of somatic status, prolonged hypodynamia, an increase in comorbid complications and loss of independent activity, and therefore, accordingly, we considered the reduction in the need for repeated surgeries as one of the most practically significant results of applying a risk-oriented approach.

The appearance of primary radiographic signs of consolidation in the control group was noted on average 6.9±2.7 weeks after surgery, while in the study group this indicator decreased to 5.1±1.9 weeks. The earlier formation of signs of reparation in patients of the study group already seemed a natural consequence of the complex effect on the mechanical and biological factors of consolidation.

The time of formation of a full-fledged CM among patients of the study group was reduced by more than 1 month, which seemed clinically significant even without statistical significance. The frequency of delayed consolidation among patients of the study group, according to the results of using the LDA developed by us, was reduced by more than 2 times ($\chi2 = 7.86$; $p = 0.005$), and the nonunion of CT fracture was reduced by 4.2 times ($\chi2 = 4.41$; $p = 0.036$), which was especially important for this category of patients, since it reduced the frequency of the need for repeated surgeries and persistent limitation of weight-bearing ability. Accordingly, the time to full weight-bearing ability was reduced by 5.3 weeks, which naturally led to increased overall patient mobility and a reduction in the incidence of deterioration in cardiovascular and respiratory adaptation, sarcopenia, and dependency on assistance.

A distinctive feature of the analyzed cohort of patients with PWS was the restoration of relatively stable weight-bearing function of the limb, a reduction in pain, and, of course, the maintenance of social activity. This, unlike in patients of working age, was of fundamental importance, as in other cases, the important criteria are restoration of work capacity and reduction of disability. However, such parameters were not appropriate for our cohort of patients. Thus, the persistence of pain syndrome under axial load after 3 months of POP among patients in the control group was observed in 22/43 (51.2%) patients, while in the main group they were reduced by more than 2 times and amounted to 10/45 patients or 22.2% (Figure 4.) Uncertainty when walking, fear of re-falling, limitation of independent movement and the need for additional support gradually led patients to a decrease in overall motor activity and increased dependence on others, and as a result, a decrease in the above phenomena in the form of functional instability in the main group was achieved by us primarily due to a relatively more reliable mechanical protection of the consolidation zone, as well as a decrease in the likelihood of micromobility of the "bone-fixator" system under the load.

Thus, functional instability of the segment as a result of the implementation of the LDA developed by us was reduced by 3 times ($\chi2 = 7.83$; $p = 0.005$), limitation of functional activity after 6 months of POP - by 2.8 times ($\chi2 = 8.66$; $p = 0.003$), as well as cases of re-hospitalization - by 3.1 times ($\chi2 = 5.42$; $p = 0.020$). For this comparison, we would like to note that even in cases where patients in the main group retained signs of delayed CM formation, the course of the CCT itself remained more controllable and mechanically stable compared to the control group, which confirmed the effectiveness of the LDA developed by us, which was based on the preventive modification of mechanical and antiresorptive support, affecting not only the radiographic indicators of consolidation, but also the quality of functional recovery of patients in the postoperative period. A comparative assessment of the dynamics of immunological parameters 6 months after surgery showed that the use of risk-oriented LDA was accompanied by a more pronounced normalization of the inflammatory-resorptive profile in patients in the study group. It should be noted that our results were of particular significance, since in the previous sections of the study, we considered the severity of systemic inflammatory activation and the predominance of resorptive remodeling as one of the key mechanisms for the formation of delayed and incompetent CCT in patients with SB fractures. Among them, we can highlight a 1.4-fold decrease in NLI, a 1.7-fold decrease in IL-6 and TNF-α levels, a 1.3-fold increase in TGF-β, and a decrease in the RANKL/OPG index 6 months after surgery from 0.81 ± 0.42 units in patients in the control group to 0.39 ± 0.21 ($t = 5.83$; $p < 0.001$) among patients in the study group. Our comparative analysis of the dynamics of immunological parameters once again confirmed that the risk-based approach we developed in LDA influenced not only the mechanical and radiographic characteristics of consolidation but also the biological mechanisms of the reparative process, as evidenced by a relatively rapid reduction in the severity of inflammatory-resorptive activation and restoration of the balance between the damaging and reparative components of bone remodeling among patients in the study group.

Quality of life in patients after osteosynthesis for TB fractures in the FSV, as analyzed over 12 months, showed an increase in the mean score not only at the poles of the curves but also in the difference, as a widening of the range. We noted improvements in the restoration of physical, everyday, and social activity in FSV patients after TB fractures. For this category of patients, such a result was of particular importance, since the clinical value of the treatment we conducted based on the risk-oriented LDA we developed was determined not only by the fact of consolidation of the cervical fracture as such, but also by the patient's ability to maintain independence, tolerate daily activities, and minimize dependence on outside help.

Thus, already 3 months after the operation, the average patient's quality of life score according to the SF-36 scale in the main group increased by 11.1±0.8 points ($p < 0.05$), after 6 months - by 16.8±1.6 points ($p < 0.05$), and after 12 months the increase was already by 19.7±2.6 points ($p < 0.05$), which confirmed our conclusion about the growth and widening of the difference between patients in the control and main groups. Such a point difference in clinical terms meant not only an improvement in well-being, but also the formation of fundamentally different levels of functional independence. Among them, there were cases in which limitations in long walking, decreased confidence when putting weight on the limb and the need for periodic use of additional support remained, whereas among patients in the main group such manifestations were much less common, that is, a more favorable course of consolidation, a decrease in the incidence of fixation instability and a reduction in the time of restoration of weight-bearing ability allowed patients to quickly return to their usual everyday and social activities. A reduced need for rehospitalizations and revision surgeries, which in PSV patients were often accompanied by a significant deterioration in overall functional status, also played a role.

Conclusions

1. The developed risk-based treatment and diagnostic algorithm for femur fractures in elderly and senile patients is based on differentiated risk assessment of consolidation failure and provides for modification of surgical tactics depending on the likelihood of mechanical decompensation of the bone-fixator system, including the use of extended structures, extended locking, cement augmentation of fixation elements, prolonged mechanical protection of the segment, and differentiated antiresorptive support. 2. The use of the developed treatment and diagnostic algorithm reduced the frequency of peri-

implant resorption by more than 2 times, secondary instability of fixation - by 3.1 times, migration of fixing elements - by 4.2 times, mechanical failure of osteosynthesis - by more than 4 times, a decrease in the frequency of delayed consolidation from 53.5% to 24.4% and fracture nonunion from 18.6% to 4.4%, as well as a reduction in the time of bone callus formation and restoration of weight-bearing ability against the background of an improvement in the quality of life of patients.

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