



## Surgical Incarnated Nail Pathology, Author Views of Some Controversion in Complex Treatment

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**Received:** February 17, 2020

**Published:** March 12, 2020

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### Abstract

In the article some controversies and aspects of the effectiveness of surgical techniques in destructive and complicated onychomycosis, associated with ingrown nail and other combined nail pathology have been resolved. Prognostic criteria for the occurrence of early and late complications and relapses, prevention schemes, complex treatment for improving functional and cosmetic outcomes and patient quality of life have been established and developed. The existing and new optimal methods and schemes of the surgical interventions have been improved and the schemes of complex treatment of combined processes including mycotic-associated lesions have been created. The aim of the work: the analysis of the actual problem of diagnostics and complex treatment of surgical nail pathology, including complicated, combined and recurrent defeat of nails and paronychia structures and new practical recommendation by developing of clinical classification criteria, methods of surgical intervention, optimization of the effective antirelapse schemes and prevention of early and late postoperative complications. The results of the retrospective and prospective analysis of 919 patients for the 10-year period are based: 503 men and 416 women aged 5-92 years old who at the surgical department of the outpatient clinic of 4 municipal clinical hospital, surgical departments of 2 and 5 municipal outpatient clinics and city dermatological hospital in Lviv were treated. Some biochemical laboratory deviations were investigated. Removal of affected nails for patients with polyonychomycosis through successive stages at add-back of systemic "pulses" therapy with itraconazole were performed. Systemic adjuvant pulse therapy with 400 mg itraconazole during two days till the initial surgical treatment of secondary incarnations and during first three years of the postoperative period were applied. Sanation of other affected nails in order to prevent from mycosis reinfection carried out with antimycotic amorolfine 5% lacquer or ciclopirox 8% nail lacquer solution. The less traumatic nail removal or resection by our techniques in patients with destructive onychomycosis, complicated subungual hyperkeratosis or onychogryphosis with nail incarnation carried out using less traumatic mobilization by onycholisation zone via a sterile blade of pedicure tool (pusher with a angle of spatula and the blade), with the use of sterile manicure blades, rounded pusher with expander/raspator, sterile rounded pusher with a bent blade and simultaneous removal of hyperkeratosis, onychomatricoma (dermatophytoma), areas of ingrowth and hypergranulation, which significantly reduces trauma and reduces of postoperative pain syndrome ( $\chi^2 =$  of 48.32,  $p < 0.01$ , Spearman coefficient ( $\rho$ ) depending on the analyzed factor 0,624-0,692). In some cases of the complicated onychomycosis and nail incarnation we believe as optimal intervention procedure the less traumatic nail removal or nail resection with the eponychectomy, the dermatophytoma excision with partial marginal matrixectomy ( $\chi^2 = 31,23$ ,  $p < 0.01$ ) that can significantly reduce the number of relapses (respectively 1 - 3% of early-stage, 3.25% and 6.42% of late recurrence of ingrowth;  $\chi^2 = 28,17$ ,  $p < 0.01$ ) and determines improve the quality of life.

**Keywords:** Surgical Nail Pathology; Destructive Onychomycosis; Nail Incarnation; Combined Nail Pathology; Clinical Classification; Complications; Comorbyde Pathology; Complex Treatment; Surgical Nail Removal; Nail Plate Resection

### Abbreviations

NI: Nail Incarnation; HOMA: The Homeostasis Model Assessment.

### Introduction

The relevance of the problem of the onychomycosis and nail incarnation (NI), ingrown nail, onychocryptosis, unguis incarnatus) in outpatient purulent surgery is caused by the increased frequency of its occurrence, chronicity, complications, early and late postoperative relapses [3,5-7,10,12]. Dermatophytes, infecting a nail matrix, determined of the dystrophic changes of a nail and subnail hyperkeratinization and dermatophytoms, surgical nail

pathology, complicated by secondary ingrowth in eponychium, and has an specifically affect of treatment in particular of the surgical nail removal [2,7,8,10,16]. The pathogenetic factors leading to increase of the probability of occurrence and development of mycosis and onychomycosis for diabetic patients include the pathology of cardiovascular and nervous systems, disruption of glycolysis, resulting in lower energy supply of skin cells and changes in metabolism, skin dysfunction, determining rapid progression and chronic mycosis [7,12,16]. Some aspects of epidemiology, etiology, pathogenesis of onychia and subungual pathology, macroscopic types of nail lesions, NI, localization, frequency and causes of complications

and relapses have been studied [2,6-8,12, 13,16]. The efficiency of different methods of surgical interventions, isolated and in combination with other methods of the complex treatment courses of the postoperative period, especially with isolated and combined lesions are analysed [3,5,6,9,13,14,17]. Scientific novelty of this problem consists that the "surgical nail pathology" [12] is singled out as a new direction of purulent surgery and dermatologic surgery, new information on the different pathogenetic mechanisms of isolated and combined onychial lesions with the allocation of specific clinical and morphological variants of the nail pathology, paronychia and subungual tissues have been obtained [2,5,7,8,9-12]. The analysis of scientific literature on the new current state of the problem of surgical onychopathology and NI were devoted [2,5,8,9,14,16]: some clinical variants, etiological factors and pathogenesis, methods of complex treatment [1,3,5,10,13,15,16]. Conservative and orthopedic treatments of NI and other mycotic surgical nail pathology are not very effective while Dupuytren's method, Emmert-Schmidner surgeries etc. are very traumatic [3,13,17], disfigure nail bone, distort anatomic and functional unity of a finger and in 2 - 20% cases (depending on absence or presence of onychocryptosis and fungal agents) cause a relapse [9,10,12,16]. The "mechanistic" approach to the treatment of the pathology of the nail and finger soft tissues, inadequate treatment in the postoperative period with purulent necrotic lesions of the distal phalanx determines to the secondary ingrowth (incarnation) of the nail plate, mycotic reinfection, osteomyelitis, secondary deformities of the nail and other different complications [2,5,6,9,12]. The most effective dermatological methods are systemic antimycotic pulse-therapy with itraconazole or terbinafine [1,10,12,15,16]; the use of antimycotic liniments in the postoperative period, which is especially shown in the complex treatment of destructive polyonychomycosis, including combined cases with onychocryptosis [9-11,14]. Complex treatment of purulent onychial pathology includes the surgical resection or removal of the nail, necrectomy, opening and drainage of purulent foci, sanation of soft tissue lesions, the conservative treatment of mycosis and comorbid lesions [1,3,5,12,13,17]. In the presence of incarnation/ingrowth of the nail, pathological deformities of the nail plates, hypergranulation and focal subungual necrosis, the basic stage of surgical treatment is supplemented with antirelapse components [3,5,6,13,14,17].

**The Aim of the Work**

The analysis of the actual problem of diagnostics and complex treatment of surgical nail pathology, including complicated, combined and recurrent defeat of nails and paronychial structures and new practical recommendation by developing of clinical classification criteria, methods of surgical intervention, optimization of the effective antirelapse schemes and prevention of early and late postoperative complications.

**Materials and Methods**

The results of the retrospective and prospective analysis of 919 patients for the 10-year period are based: 503 men and 416 women aged 5-92 years old who at the surgical department of the outpatient clinic of 4 municipal clinical hospital, surgical depart-

ments of 2 and 5 municipal outpatient clinics and city dermatological hospital in Lviv were treated. Some clinical and paraclinical, microbiological methods, functional diagnostics, renthenological, biochemical, morphological and statistical methods according to the study design were applied. In 186 patients late relapses of onychocryptosis were confirmed after previous surgeries at other clinics. Conservative treatment was recommended only at early stages of ingrowth. System therapy of itraconazole to operative treatment (basic onychial defeats sanation) and in a postoperative period was carried out. Removal of the affected nails was performed in patients with mycotic lesions (local and systemic fungicide therapies were used) [1,4,10,15,16]. Investigation of the morphogenesis of destructive aspect of the mycotic lesions was carried out. Retrospective material were 295 observations of uncomplicated destructive surgical nail pathology: 177 men and 118 women, the patients age from 11 to 85 years old. Young patients were 26.44%, the average - 32.20% and the elderly - 41,36% of the retrospective subset. Prospective material were 624 cases of nail destruction: 326 males and 298 females, age of operated patients - from 5 to 92 years old. Also peculiarities of treatment, some indicators of lipid exchange of patients with diabetes mellitus, metabolic syndrome accompanied by destructive onychomycosis and secondary NI were investigated. Removal of affected nails for patients with polyonychomycosis through successive stages at add-back of systemic "pulses" therapy with itraconazole were performed. Systemic adjuvant pulse therapy with 400 mg itraconazole during two days till the initial surgical treatment of secondary NI and during first three years of the postoperative period were applied. Also with antimycotic therapy and correction of comorbid pathology the following procedures were carried out: excision of pathologic eponychial tissues, hypergranulations and necroses, resection NI or removing nail plate with partial marginal matrixectomy in the ingrowth area [3,5,6,13,17]. Non-invasive methods of nail excision and marginal nail resection in 24.7% patients of the main group and in patients with diabetes mellitus were used. Sanation of other affected nails in order to prevent from mycosis reinfection carried out with antimycotic amorolfine 5% lacquer or ciclopirox 8% nail lacquer solution [1,4,15]. Removal of other trichophytosis nails (through onycholysis) in separate stages with itraconazole therapy were combined [15]. The analysis of the patients basic distribution in the main group and the comparison (control) group by age did not reveal any significant difference ( $p > 0,05$ ). The change in the different indices before and after the treatment using the Wilcoxon test has been identified. The difference in the studied parameters was considered at  $p \leq 0.05$ . Some standard methods of statistical analysis from 95% confidence interval and t - criterion of Student have been applied, the Pearsons and the Spirmens method,  $\chi^2$  (was determined by the degree of influence of etiological factors, morphogenetic mechanisms, correlation between nosological forms, morphological manifestations and the efficiency of complex treatment), the regression models ANOVA and CATREG were used. The analysis justifies the feasibility of establishing predictive relationships between clinical variants of chronic purulent necrotic infections and combined comorbidity [7,8,9,10].

Results and Discussion

The peak incidence of uncomplicated cases (including onychocryptosis) in patients aged 30 - 40 years old, the mediately growth in the frequency of complicated clinical observations - in 30 - 40 year old and 60 - 70 year old patients, some combined lesions - in patients 40-50 year old were observed. It was ascertained that young people mostly are affected by uncomplicated onychocryptosis,  $\chi^2 = 24.12$ ,  $p = 0.028$ ; some old patients are affected by mycotic onychodestruction: expressed total nail plate hypertrophy, onychogryphosis, subungual dermatophytoms, secondary NI and other mycotic changes ( $p = 0.012$ ), which may be in some patients the cause of the distal phalanx mycotic associated osteomyelitis. These variants of the secondary nail destruction at polyonychomycosis are character for the middle age and the elderly patients (influence degree  $\chi^2 = 24.12$ , significance level  $p = 0.028$ ). The most were the changes of the complicated onychomycosis ( $\chi^2 = 20.87$ ,  $p < 0.01$ ) and the total mycotic nail destruction, the secondary NI were diagnosed,  $\chi^2 = 17.35$ ,  $p = 0.022$ , Spearman's coefficient ( $\rho$ ) in the studied groups was 0.552-0.617, which was determined the deformity and accompanied by the nail incarnation in eponychial tissues,  $\chi^2 = 5.11$ -36.22,  $p < 0.05$ . Surgical intervention was performed taking into account pathological changes,  $\chi^2 = 21.23$ ,  $p = 0.012$ , according to the recommendations of a combination of surgical interventions and conservative therapy,  $\chi^2 = 28.17$ ,  $p < 0.01$ . The removing the nail for Dupuytren and other known surgical methods, some controversion of refusal to perform of simultaneous surgical interventions in paronychia and subnail structures in the combined mycotic-associated lesions are the failure to take into account the morphological changes of the mycotic subcutaneous hyperkeratosis,  $\chi^2 = 22.18$ ,  $p < 0.01$  [2,5-7,11,12]. The imperfection of surgical techniques account an over half of the causes of incarnations recurrence, including some cases combined with NI, subnail hyperkeratosis or onychogryphosis,  $\chi^2 = 20.13$ , significance level,  $p < 0.01$ , the highest frequency for technical reasons of recurrence are ascertained, unreasonable refusal of the partial matrixectomy [6,13,14,17] - 19.8% sub-sample and traumatic nail mobilization/removal (traumatic onychectomy) - 17.25% sub-sample. Retro- and prospectively studied 414 cases of NI, including onychocryptosis as the uncomplicated variant of nails ingrowth. The pathogenesis of incarnation is difficult enough and can be simultaneously existing 1-4 "vicious circles",  $\chi^2 = 27.41$ ,  $p < 0.01$ , Spirman's coefficient ( $\rho$ ) in the studied groups 0.552-0.617. The manifesting and latent-running cases of ingrown nail, other chronic and associated nail pathology associated with onychocryptosis are diagnosed [10-12]. It has been confirmed that the complicated and combined cases of onychocryptosis and mycotic lesions accounted almost half - 196 (44.95%) of all observations; cases of uncomplicated manifesting NI - 167 (38.3%) of the sample. The age of patients with complicated surgical onychopathology associated with ingrown nail are: 51.8% - patients 20 - 40 year old, such a lesion was confirmed in 91 patients aged 20 - 30 years (20.9% of the total sample) and in the other 97 (22.25%) - of 30 - 40 year old. Patients 40 - 50 year old including 75 observations (17.2%); 24 (4.5%) cases of incarnated surgical nail pathol-

ogy are persons aged 50 - 60 years. Complicated NI in patients of other age groups was relatively rare. The peak of observations of uncomplicated onychocryptosis occurred in the groups of 20 - 40 year old patients, the peak of cases of destructive trichophytic lesions with incarnation was observed in other 40 - 50 year old and 50 - 60 year old patients. Most often the left foot hallux was affected - in 48.85% of the sample, the right foot - in 33.26%, the presence of NI of the both feet hallux was detected in 17.89% patients. In 82 cases (18.8% of the sample), the disease occurred against the background of obliterating diseases of the lower extremities arteries by atherosclerosis in 60 (13.76%) and diabetes in 22 patients (5.05%). In 113 patients (25.92% of the total sample), ingrown nail with deformation of the matrix (longitudinal deformation or untypical transverse central deformation) [2,7,8] and the formation of eponychial hypergranulations and local necrosis [3,5,6,14,17] or osteomyelitis [9,10,12] was confirmed by their contamination with the Candida spp. and T. Rubrum, confirms the results of our previous studies, in 37 of them this was the cause of the appearance of distal-lateral onychomycosis. Chronic necrotic-purulent process, proliferation of hypergranulation tissue are good "entrance gates" for the penetration of mycotic infection [9,10,16]. Onychomycosis in such cases (mainly in young people) often has the character of secondary disease and can manifest itself as a distant complication in the postoperative period; can also cause secondary deformations and late relapse of the nail incarnation. I decided to optimize and implement clinically the my new author's version of IN "ENMK" classification [11,12] by adding a description of the morphological characteristics of the nail bed; alphanumeric coding, the full "spectrum" of clinical variants of NI in non-mycotic and mycotic ingrowth is maximally encompassed [5,9,10]. E (eponychium pathology). Type 1 - infiltrative inflammation. Type 2 - acute eponychial abscess. Type 3 - chronic purulent-necrotic process with the serous or (and) purulent chronic eponychial exudation without granulation. Type 4 - chronic purulent-necrotic inflammation with the formation of focal necrosis and hypergranulation. Type 5 - ingrown toenail associated by purulent eponychial inflammation and periostitis or osteomyelitis or/and subungual exostosis of distal phalanx. N (nail, nail plate). Type 1 - the lateral edge of the nail is macroscopically unchanged or slightly changed. Type 2 - lateral nail "spur" (spicula). Type 3 - the lateral edge of the nail is scalloped or jagged (multiple nail spurs). Type 4 - thickened, festooned and laminated the lateral edge of the nail. Type 5 - focal-stratified the lateral edge of the nail. M (matrix deformation). Type 1 - the deformation of the nail matrix is absent or insignificant. Type 2 - pronounced marginal longitudinal deformation of the nail matrix. Type 3 - central longitudinal deformation of the matrix and tent-like nail deformation. Type 4 - longitudinal deformation of the matrix with tubular nail deformation (pincer nail). Type 5 - untypical transverse central deformation with the distal nail incarnation. C (comorbid pathology). Type 1 - there are no associated nail defects and background vascular and/or neurotrophic pathology of the lower extremities. Type 2 - available accompanying non-fungal deformation of the nail. Type 3 - available accompanying mycotic deformation and destruction of

the nail and/or subungual structures. Type 4 - available background vascular and (or) neurotrophic pathology of the extremities. Type 5 - available accompanying lesions of the nail (including fungal lesions) and background vascular and (or) neurotrophic pathology of the extremities. In 53.86% of the prospective subsample observations, onychomycosis and ingrown nail were identified. Percentage of ingrowth recurrence (from the general sample) with the classical surgical treatment varies of 6.15% - 13.85%, which corresponds to effectiveness world standards for surgical interventions for onychocryptosis (ingrown nail). The existence of 18 methods of surgical treatment of NI has been confirmed. The applied of 7 basic type of nail pathology surgical treatment may be divided into main groups: Emmert-Schmid type surgeries (marginal excision of nail plate and eponychia with marginal removal of the growing part via partial matrixectomy) [3,5,14]; Dupuytren's type surgeries (onychectomy - complete removal of nail plate) [9]; Bartlett type surgeries (local tissue plastic reconstruction) [9-12]; marginal resection of marginal section of nail plate; Meleshevych surgery [12]; Winograd technique [13,17]; our modifications (with previous block-type onychectomy). The use of monocomponent palliative-non-decompression interventions (marginal nail resection or removal of the nail plate) is only possible in the initial ingrowth stage, in the pronounced infiltrative-inflammatory changes of the eponychial tissues; however in these cases it is more appropriate to use two-component (conditionally radical with anti-recurrent component) interventions,  $\chi^2 = 12,11$ ,  $p = 0,024$ ; which allows to significantly reduce the relapses risk (respectively, 3.25% and 6.42%);  $\chi^2 = 28,17$ , level of significance,  $p < 0,01$ . Objectivity of the NI relapse assessment depends on the severity of pathological changes in the edge of the nail plate [6-8], to a lesser extent - from pathological changes of eponychial tissues [6,7]. Increase of the partial percentage of the incarnation recurrence suggests the necessity of the marginal matrixectomy,  $\chi^2 = 31,23$ ,  $p < 0,01$ , in the ingrowth area, as the anti-recurrent component  $\chi^2 = 18,21$ ,  $p < 0,01$  (respectively 1 - 3% of early-stage, 3.25% and 6.42% of late recurrence of ingrowth;  $\chi^2 = 28,17$ ,  $p < 0,01$ ). We propose the methods of surgical treatment of incarnations protected by Ukrainian patents, and the use of partial matrixectomy is recommended as the main anti-relapse measure of three-component surgical interventions, which reduces the number of compression relapses [12],  $\chi^2 = 31,23$ ,  $p < 0,01$  to 1-3% of the total sample of clinical observations. Author's method of nail edge visualisation, a block-shaped onychectomy [9-12] for a complicated and combined ingrown nail were used. Departing 2-3 mm from the edge of the nail we perform the retronychial linear incision of soft tissue to the nail plate and carving "en block" of eponychial tissue with micro-abscesses, necrosis and hypergranulation. We exfoliate the lateral remains of eponychial tissue fragments from the ingrowth nail edge via a sterile blade of pedicure tool (pusher) PE-60/1 (with a angle of spatula and the blade). Perform a visual macroscopic assessment of the presence of deformation of the lateral nail edge, delamination, foci of hyperkeratosis and onycholysis to select the volume of regional/marginal nail resection or total nail removal. Dissect the ingrowth nail edge from the nail bed and matrix to vi-

sually healthy tissue by sliding movements with the use of sterile manicure blades PE-10/2 (rounded pusher with expander/raspator) and a sterile nail tool PE-30 (rounded pusher with a bent blade) and perform the partial nail resection or nail removal with sanitation the nail resection area via a sterile pedicure blades with operation abrasive file PE-60 (PE-60/2 with rasp at an angle and rasp with a curved end) and performed the partial marginal matrixectomy with a longitudinal mechanical excision and coagulation of a germination zone and nail matrix of the ingrowth area. Sanitation of eponychial channel and sinuses perform with a Volkmann spoon and sterile pusher. The wound sanitation with 3% hydrogen peroxide solution and an solution of Polyvidone-iodine and the tamponade under visual hemostatic control were used. Timely surgical treatment of NI adequately prevented some complications and relapses,  $\chi^2 = 28,13$ ,  $p < 0,01$ , including mycotic mixed infection.

Retrospective and prospective analysis of 469 cases (51.03% of the sample) of destructive onychomycosis, combined nail pathology in 14-95 years old patients, 367 men and 102 women are presented. In the analysis of the results obtained a direct relationship between the anamnesis data ( $y = 16,9$   $p < 0,05$ ,  $r = 0,7$ ), as well as clinical manifestations and areas of skin and nail plate damage with arterial pathology ( $y = 15,5$ ,  $P < 0,05$ ,  $r = +0,8$ ). In patients of the basic group in peripheral reovazograms increased tone of small vessels. The rheographic curves had spastic appearance in 48,7% of observations, in 32,1% - hypotonic and dystonic in 19,2%. In patients with onychomycosis, especially in disseminated forms, some deterioration of the microcirculation was noted. The spastic type of rheographic curves are dominated ( $y = 30,6$ ,  $P < 0,01$ ). The index of open capillaries was reduced to 31%. All old patients atients with polyonychomycosis showed the clinical signs of polyhypovitaminosis, some deviations of laboratory parameters. There was a positive correlation between the level of total cholesterol and leptin ( $r = 0,38$ ;  $p < 0,01$ ). An elevated total cholesterol level of more than 5.2 mMol/L was observed in patients in the main group, -  $6.31 \pm 0.09$  mMol/L, and in patients with control, -  $6.33 \pm 0.11$  mMol/L. The level of LDL cholesterol was more than 3.0 mMol/L in patients with the main group, -  $3.34 \pm 0.2$  mMol/L, in patients with control group, -  $3.32 \pm 0.15$  mMol/L, Spirman's coefficient ( $\rho$ ) in the studied groups 0.513-0.609. Concentration of HDL cholesterol in patients with the main group was  $1.36 \pm 0.05$  mMol/L, in patients with control group -  $1.12 \pm 0.03$  mMol/L. The average content of nitric oxide in patients with the main group who performed a standard onychectomy was slightly higher -  $15.46 \pm 0.35$   $\mu$ Mol/l,  $p < 0.05$  ( $\chi^2 = 8.11$ , significance level,  $p = 0.032$ ), in comparison with some cases who used a less traumatic removal of mycotic nails changes, this parameter also was slightly different from those with uncomplicated onychomycosis, respectively  $12.32 \pm 0.23$   $\mu$ Mol/l and  $11.62 \pm 1.51$   $\mu$ Mol/l,  $p > 0.05$ . A retrospective and prospective analysis of 108 cases of destructive polynychomycosis, on the background of metabolic syndrome and diabetes mellitus, complicated by purulent diseases of the nail and eponychial tissues were performed. In 61 patients, the presence of type 1 diabetes (insu-



lin dependent), and in the other 47 patients - type II (non-insulin dependent) was noted. In patients with diabetes mellitus with polyonychomycosis and trichophytic subungual hyperkeratosis, secondary incarnation (108 observations, 11.88% of the sample) was ascertained a different changes in the biochemical parameters are associated of the lipid metabolism, elevated cholesterol levels more than 5.18 mmol/l, HDL cholesterol  $1,12 \pm 0,06$  mmol/l,  $p < 0.05$ , the insulin resistance [9], HOMA-index of insulin resistance ( $8,11 \pm 1,1$ ,  $g < 0.01$ ), and glycated hemoglobin ( $11.1\% \pm 1,5\%$ ,  $R < 0.05$ ), the reduction of  $\beta$ -cell function and increase of HOMA-IR index, correlations of glucose levels with insulin ( $r = 0.52$ ;  $p < 0.01$ ), with HOMA index ( $r = 0,69$ ;  $p < 0.01$ ), with glycated hemoglobin ( $r = 0,76$ ;  $p < 0.01$ ); insulin with the HOMA index ( $r = 0.74$ ;  $p < 0.01$ ) and glycated hemoglobin ( $r = 0,65$ ;  $p < 0.01$ ); index HOMA with glycated hemoglobin ( $r = 0,69$ ;  $p < 0,01$ ) [12]. There is a correlation in patients with diabetes mellitus between the level of glycated hemoglobin and the frequency of occurrence of complicated onychomycosis, secondary NI and nail deformation [7,8,11],  $\chi^2 = 28.21$ ,  $p < 0.01$ . The frequency of foot mycoses and onychomycosis in diabetic patients exceeds this index for patients in the general population,  $\chi^2 = 13.69$ , which is also confirmed by the results of two-factor dispersion analysis,  $p < 0.05$ . In patients with minimal and intermediate defeat, the blood glucose level and glucose tolerance were within the normal range, and the nail fibers hexoses was 0.116-0.121 nmol/mg, which is a reliable indicator ( $p = 0.033$ ). In patients with complicated NI significant candidiasis lesions and relapses [12], the hexose level reached 0.138 nmol/mg. In patients with candidiasis lesions and diabetes, the level of nail fibers hexoses was more than 0.131 nmol/mg,  $\chi^2 = 18.11$ , which was also confirmed by the results of dispersion analysis,  $p < 0,05$ . In patients with mixed or trichophytic infection, this level was higher and amounted to more than 0.141 nmol/mg.

From the nail plate and the affected nails matrix, the most frequent *T. rubrum* and *S. albicans*, less often *T. Mentagrophytes* were identified. It was found that subungual hyperkeratosis and dermatophytoma [2,7-10,15] due to the compression of the central part of the nail determine the secondary incarnation of the nail edges [9-12],  $\chi^2 = 20,87$ ,  $p < 0,01$ . An analysis of subnail substances with onychomycotic lesions with secondary NI allowed to state the predominance of dermatophytes (red trichophytes),  $\chi^2 = 35.43$ ,  $p < 0.01$ , in the third of patients the associations of mycotic pathogens and bacterial flora were identified. The addition of candidosis, bacterial or mixed superinfection [16] in 21.08% patients is responsible for the formation of asymptomatic mixed etiology subungual panaritium (multiple purulent centers macroscopically resemble of "honey cells"), which is the direct cause of the disabling complications, including the chronic mycotic associated osteomyelitis of the distal phalanx. In patients with onychomycosis associated with secondary NI [10-12] are a total fungal infection with nail hypertrophy, the formation of subungual hyperkeratosis or onychogryphosis,  $\chi^2 = 20.41$ ,  $p < 0.01$  and onychomatricoma (dermatophytoma, trychophitoma), which creates difficulties for the mobilization and surgical removal of affected nails. The scheme

of complex treatment, pulse therapy with itraconazole, removal of damaged nails, treatment of the nail bed with polyvidoniodine, the use of liniment of terbinafine and the sanation of other nail plates with antimycotic laquers - cyclopyrox or amorolfine [1,15], which can be used for the treatment of hard polyonychomycosis cases are suggested. Surgical removal of the mycotic affected nails of these patients should reasonably be conducted through stratified of subnail hyperkeratosis and onycholized structures with simultaneous removal of dermatophytoma, hyperkeratosis, and ingrowth areas with hypergranulation. Methods of surgical treatment of subnail hyperkeratosis and onychogryphosis with or without recurrent NI have been improved considering patho- and morphogenesis of destructive complicated polyonychomycosis. The foci of the onycholysis and destruction of hyperkeratosis, which leads to the onycholysis and detachment of the nail plate and secondary NI,  $\chi^2 = 15,23$ ,  $p < 0,0211$ , determined and justifies the feasibility of a less traumatic onychomyectomy (methods protected by the Ukrainian Patents) with one-stage sequential nail removal of dermatophytoma and growth zone with eponychial tissues. The removal of the affected nails in patients with destructive onychomycosis, complicated subungual hyperkeratosis or onychogryphosis with NI carried out using less traumatic mobilization by onycholisation zone via a sterile blade of pedicure tool (pusher) PE-60/1 (with a angle of spatula and the blade), with the use of sterile manicure blades PE-10/2 (rounded pusher with expander/raspator) and a sterile nail tool PE-30 (rounded pusher with a bent blade), simultaneous removal of hyperkeratosis, onychomatricoma (dermatophytoma), areas of ingrowth and hypergranulation, which significantly reduces trauma and reduces of postoperative pain syndrome ( $\chi^2 =$  of 48.32,  $p < 0.01$ , Spearman coefficient ( $p$ ) depending on the analyzed factor 0,624-0,692), and determines improve the quality of life of patients. Intra - and postoperative prevention of mycotic re - and mixedinfections is offer by using optimized schemes for the system (the pulse therapy of 400 mg of Itraconazole per day) [3,4,15,16], local antimycotic therapy (liniments polyvidoniodine, terbinafine), nail lacquer (ciclopirox, amorolfine), which increase the the probability of clinical and mycological recovery [1,4,8,16]. The associations of mycotic pathogens and bacterial flora in 31% cases,  $\chi^2 = 20,87$ ,  $p < 0,01$  determines the acute purulent processes [10,12]. In patients with onychomycosis associated with secondary NI is a total nail hypertrophy with a formation of subnail hyperkeratosis or onychogryphosis and subungual dermatophytoma  $\chi^2 = 28,45$ ,  $p < 0,01$ , which creates difficulties with the mobilization and removal of affected nails. In patients with diabetes mellitus, which was used as a less traumatic onychectomy, the terms of complete wounds healing were 16-23 days (average duration of healing - 19 days). In patients with diabetes and "classical" onychectomy this term were 24-30 days, respectively (average healing duration was 26 days), in the control group were 14-22 days (average healing duration was 18 days). In patients with type 2 diabetes mellitus who have the less traumatic mycotic nail removal through onycholysed structures, the terms of healing of the germination zone and nail matrix wounds were smaller and was conscious to those in the control group (with normal glycemia) with destructive polyonyhomycosis,

onychogryphosis with secondary NI,  $r = 0.38$ ;  $p < 0.01$ . At the 14th day the Popova's index in the main group was 18.97% (from 15.3 to 21.8%), in the control group it was  $12.1 \pm 2.85\%$ , ( $\chi^2 = 32,14$ ,  $p < 0.01$ ), indicating that significant advantages of less traumatic onychectomy in comparison with the classic methods. In patients receiving oral terbinafine, clinical remission in the 1.5 years after the start of treatment was 78.26%, while in the group receiving itraconazole and topical terbinafine liniment was 82.69%. Investigation of the immune status of patients with destructive polyonychomycosis immediately after operative treatment and after 1 month of the postoperative period allowed to state the normalization of some indicators and their approximation to the indicators in the control group without a special immuno-correction ( $r = 0.42$ ;  $p < 0.01$ ), indicating the effectiveness of complex treatment using surgical techniques, decreases the risk of contamination of other structures ( $\chi^2 = 27,41$ ,  $p < 0.01$ ). The maximum relapse rate for polyonychomycosis is observed for 12-15 months,  $\chi^2 = 25,52$ ,  $p = 0,018$ , in the case of systemic therapy - in the third year after treatment,  $\chi^2 = 13,47$ ,  $p = 0,023$ , which is often an indication for repeated interventions,  $\rho = 0.511-0.791$ . Errors in surgical technique was 139 cases of the reasons for the recurrence of incarnations, including cases, combined with subungual hyperkeratosis or onychogryphosis ( $\chi^2 = 20.13$ ,  $p < 0.01$ ), the partial matrixectomy failure [3,5,10,13,14,17] in the conditions at the mycological contamination (56 observations, 44,62% in subsamples), insufficient removal of pathologic eponychial changes (36 cases of relapse), inefficient use of antimycotic therapy when combined nail lesions (47 patients, 11.35% incarnations). Resection or less traumatic nail removal through onycholized structures with removal of dermatophytoma, hyperkeratosis, incarnations, hypergranulation and partial matrixectomy optimize the results of treatment,  $\chi^2 = 27,43$ . Systemic therapy in combination with the affected nails removal, the use of liniment terbinafine and antimycotic lacquers positively allows to complete the treatment in 92,3% cases of monoonychomycosis, combined cases with incarnation and/or other purulent mycotic complications.

Conclusions

Late causes of unsatisfactory results of complex treatment of onychopathology, in particular ingrown toenail, resulting in relapse (186 observations, of 20.24% of the sample) is the disregard of the morphological features of mycotic subungual hyperkeratosis under the nail removal with Dupuytren method and other known traumatic methods of surgical treatment ( $\chi^2 = 22,18$ , significance level,  $p < 0.01$ ), traumatic nail removal were 70 cases (16,9% subsamples of the nail incarnations), Some errors in surgical technique was 139 cases 74,73% among the reasons for the recurrence of incarnations, including cases, combined with subungual hyperkeratosis or onychogryphosis ( $\chi^2 = 20.13$ ,  $p < 0.01$ ), the partial matrixectomy failure in the conditions at the mycological contamination (56 observations - 44,62% subsamples of relapse), insufficient removal of pathologic eponychial changes (36 cases of relapse), inefficient use of antimycotic therapy when combined nail lesions (47 patients, 11.35% incarnations), which were the

main factors of development of relapses in the late postoperative period. In some cases of the complicated onychomycosis and nail incarnation we believe as optimal intervention procedure the less traumatic nail removal or nail resection with the eponychectomy, the dermatophytoma excision with partial marginal matrixectomy ( $\chi^2 = 31,23$ ,  $p < 0.01$ ) that can significantly reduce the number of relapses (respectively 1 - 3% of early-stage, 3.25% and 6.42% of late recurrence of ingrowth;  $\chi^2 = 28,17$ ,  $p < 0.01$ ). The less traumatic nail removal or resection by our techniques determine statistically significant increase in the rate of wound healing, Popova's index ( $\chi^2 = 32,14$ ,  $p < 0.01$ ), thus achieving reduction of intraoperative injury to unaffected parts of the nail bed, ( $\chi^2 = 20.13$ ,  $p < 0.01$ ), decreases the risk of contamination of other structures ( $\chi^2 = 27,41$ ,  $p < 0.01$ ), characterized by a decrease in the intensity of the pain ( $\chi^2 = 48.32$ ,  $p < 0.01$ , Spearman coefficient ( $\rho$ ) depending on the analyzed factor 0,624 - 0,692) and determines some positive changes of the patients quality of life.

Conflict of Interest

The author declares no conflict of interest.

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