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HYPOGASTRIC SKIN MICROBIOCENOSES. IS THERE AN ASSOCIATION WITH THE RISK OF POSTOPERATIVE INFECTION?

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The purpose of the study was to assess the state of hypogastric skin microbiocenosis in women with total hysterectomy due to uterine bleeding.

Material and methods. The study was conducted on the basis of the clinical divisions of the Department of Obstetrics and Gynaecology of ONMedU in 2020–2022. 34 women aged 35–55 who had total hysterectomy due to uterine bleeding were examined. Women with a normotrophic status (BMI – 18–25 kg/m^2, n=11) belonged to group I, with a hypertrophic status (BMI – 25.1–30.0 kg/m^2, n=13) – to group II, obese women (BMI more than 30 kg/m^2, n=10) – to group III.

In the preoperative period, general blood and urine analysis were performed in all patients, the hormonal (FSH, LH, testosterone, prolactin, progesterone, estradiol, leptin) and lipid profile, as well as the composition of the lower abdomen skin microbiocenoses were evaluated. Statistical processing was carried out by methods of dispersion and correlation analysis using Statistica software 14.1.25 (TIBCO, USA).

Results. The average BMI in patients of group I was (20.9±0.8) kg/m^2, group II – (26.6±0.7) kg/m^2, group III – (32.9±1.1) kg/m^2 ($p<0.05$). All women of group III and 7 (53.8%) women of group II showed signs of dyslipidemia. The leptin content in obese patients was (9.2±0.7) ng/ml, significantly higher than the levels achieved in group I (5.3±0.3) ng/ml and group II (6.4±0.4) ng/ml.

Conclusions:

1. Qualitative composition of hypogastric skin microbiocenosis depends on nutritional status.
2. A correlation of medium strength was established between the level of estradiol and the detection of opportunistic flora (rs=0.36; $p<0.05$). The detection rate of opportunistic flora is also correlated with BMI (rs=0.33; $p<0.05$).
3. The impact of the qualitative composition of hypogastric skin microbiocenosis on the risk of postoperative infectious complications is inconclusive.

Keywords: skin microbiocenoses, Pfanenstiel incision, risk assessment, prevention, infection control.

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МІКРОБІОЦЕНОЗИ ШКІРИ ГІПОГАСТРАЛЬНОЇ ДІЛЯНКИ. ЧИ Є ЗВ’ЯЗОК ІЗ РИЗИКОМ ПІСЛЯОПЕРАЦІЙНОЇ ІНФЕКЦІЇ?

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Метою дослідження була оцінка стану мікробіоценозу шкіри гіпогастральної ділянки у жінок, яким виконували тотальну гістеректомію з приводу маткової кровотечі.

Обстежено 34 жінки у віці 35–55 років. Середній ІМТ у пацієнток І групи становив (20,9±0,8) кг/м^2, ІІ групи – (26,6±0,7) кг/м^2, ІІІ групи – (32,9±1,1) кг/м^2 ($p<0,05$). У всіх жінок ІІІ групи та у 7 (53,8%) жінок ІІ групи виявлені ознаки дисліпідемії. Показано, що якісний склад мікробіоценозів шкіри гіпогастральної ділянки залежить від аліментарного статуса.

Встановлено наявність кореляційного зв’язку середньої сили між вмістом естрадіолу та виявленням умовно-патогенної флори (rs=0,36; $p<0,05$). Частота виявлення умовно-патогенної флори корелювала також з ІМТ (rs=0,33; $p<0,05$). Вплив якісного складу мікробіоценозів шкіри гіпогастральної ділянки на ризик післяопераційних інфекційних ускладнень є непереконливим.

Ключові слова: мікробіоценози шкіри, розріз за Пфаненштилем, оцінка ризику, профілактика, інфекційний контроль.

Introduction. In 1900, the German gynecologist Hermann Johannes Pfannenstiel proposed a new surgical approach that is now the standard for many interventions in obstetrics and gynecology, urology, and orthopedics [1]. The Pfannenstiel incision provides a wide view of the central pelvis but limits access to the lateral pelvis and upper abdomen, which limits the usefulness of this incision for radical interventions [1, 2].

This incision is commonly referred to as the "bikini line incision". It is often used for operative delivery, taking into account its advantages over other types of incisions for aesthetic reasons, as the scar will be hidden by pubic hair. The incision does not disfigure the navel and heals faster than the traditional vertical incision in a midline laparotomy [1].

When performing surgery on normal-weight women, most obstetricians prefer the Pfannenstiel incision because it is associated with less postoperative pain and better cosmetic results [3–5]. However, whether the Pfannenstiel incision is the best choice for obese women remains a matter of debate. Obesity, which affects 10 to 30% of pregnant women [6], leads to panniculus, an excess of skin and subcutaneous fat in the lower abdomen that resembles an apron. For caesarean section in obese women, some authors prefer the Pfannenstiel incision made in the infra-pannicular fold [4], while others advocate a vertical abdominal incision due to concerns about making an incision under the panniculus in a warm, humid, anaerobic environment that favors the growth of numerous microorganisms [5].

Indeed, the skin is an epithelial barrier to the external environment that also supports a diverse microbiota consisting of bacteria, fungi, viruses and micro eukaryotes. The skin microbiota is adapted to live in unique microenvironments that determine the environmental and nutritional conditions of this ecosystem. Interacting together and through mutualistic or commensal interactions with mammalian host cells, the skin microbiota contributes to defence and immune responses, inhibits colonization and infection by opportunistic or pathogenic organisms, and promotes tissue repair and barrier functions [7].

The skin offers protective niches and nutrients for microbial survival, competition and cooperation. On a microscopic scale, the sebaceous unit is a protective invagination that provides a microaerophilic environment for obligate and facultative anaerobes. On a macroscopic scale, such folds as the navel create a closed environment that retains moisture and resists external influences. Sebum, secreted by the sebaceous glands, is a source of lipids that can be used as a source of nutrients. For example, the bacterium *Propionibacterium acnes* produces lipases that break down sebum lipids, allowing it to use the resulting fatty acids as nutrients. These fatty acids also acidify the surface of the skin, thereby creating an environment that prevents colonization by exogenous microorganisms. Other nutrients available on the skin include salts secreted from the sweat (eccrine and apocrine) glands and cellular debris rich in proteins and lipids produced by the desquamation or sloughing off of the stratum corneum of the epidermis as a result of the process of terminal differentiation. Although the surface of the skin mostly dries out with a few exceptions, the lipids, salts and cellular debris provide sufficient nutrients for survival, especially for those microbes that are adapted to generally inhospitable conditions. On the other hand, for more demanding microorganisms, the skin is an unfriendly environment [7, 8]. It remains an open question whether the qualitative composition of the skin microbiocenosis at the site of the future incision can affect the risk of postoperative infectious complications.

The aim of the study was to assess the state of hypogastric skin microbiocoenosis in women with total hysterectomy for uterine bleeding.

Material and methods. The study was conducted on the basis of the clinical units of the Department of Obstetrics and Gynecology of ONMedU in 2020–2022. We examined 34 women aged 35–55 years who had total hysterectomy for uterine bleeding. Depending on the nutritional status, the women were divided into three clinical groups. Group I included women with normotrophic status (BMI – 18–25 kg/m^2, n=11), group II – women with hypertrophic status (BMI – 25.1–30.0 kg/m^2, n=13), group III – obese women (BMI over 30 kg/m^2, n=10).

At the preoperative period all the patients had general blood and urine analysis, hormonal (FSH, LH, testosterone, prolactin, progesterone, estradiol, leptin) and lipid profile, as well as the composition of the lower abdomen skin microbiocenosis were assessed [9–11]. The system of infection control measures met the requirements of current clinical guidelines [12, 13].

For the transport of biospecimens (skin swabs), Polyvinylpyrrolidone (PVP) 360 (Sigma Aldrich, USA) and UTM (China) transport media were used. Subsequently, bacterioscopic, bacteriological and PCR studies were performed. The latter was performed with 16S RNA primers (16S V1-V3, V4 primers) and ITS2 (MI, Canada) [11].

The study was performed in compliance with bioethical requirements, all patients signed an informed consent form. The study programme was approved by the ONMedU Bioethics Committee (Protocol No. 13 of 10.05.2020).

Statistical processing was carried out by variance and correlation analysis using Statistica software 14.1.25 (TIBCO, USA) [14].

Results and discussion. The average age of the examined patients was (48.1±0.4) years. The clinical and anamnestic characteristics of patients assigned to different clinical groups did not differ.

The average BMI in patients of group I was (20.9±0.8) kg/m^2, group II – (26.6±0.7) kg/m^2, group III – (32.9±1.1) kg/m^2 ($p<0.05$). All women of group III and 7 (53.8%) women of group II showed signs of dyslipidemia. At the same time, the average levels of total cholesterol and its fractions in group I did not exceed the reference values (Table 1).

Table 1

Lipid profile of the examined women

Indicator	Group I (n=11)	Group II (n=13)	Group III (n=10)
Total cholesterol, mmol/l	4.8±0.4	5.7±0.3	6.1±0.5
	2.2–7.4	3.6–7.8	3.0–9.0
Triglycerides, mmol/l	1.1±0.2	1.3±0.2	1.5±0.3
	0.1–2.4	0.1–2.7	0.1–3.4
HDL, mmol/l	1.5±0.2	1.3±0.2	1.2±0.3
	0.2–2.8	0.1–2.7	0.1–3.1
LDL, mmol/l	2.9±0.3	3.3±0.2	4.8±0.3*
	0.9–4.9	1.9–4.7	2.9–6.7

*Note: * – differences with other groups are statistically significant (p<0.05).*

When assessing the hormonal profile, there were no significant differences between the clinical groups, but in groups II and III the variance of the relevant indicators was greater (Table 2). The tendency to increase the amount of estradiol in patients of group III may be explained by an increase in the intensity of androgen aromatization by adipose tissue.

The exception is leptin, which in obese patients was (9.2±0.7) ng/ml, which is significantly higher than the levels achieved in groups I and II (5.3±0.3) ng/ml and (6.4±0.4) ng/ml, respectively.

As for the qualitative composition of skin microbiocenosis in the examined women, further studies have shown that шп the presence of metabolic syndrome and obesity, the detection rate of opportunistic flora representatives including *Corynebacterium spp., staphylococci and streptococci* increases (Table 3).

As shown in Figure 1, depending on BMI, the presentation of various components of skin microbiocenosis changes, primarily due to an increase in the quota of transient flora.

When comparing the hormonal profile and the qualitative composition of skin microbiocenosis, a medium correlation was found between the content of estradiol and the detection of opportunistic flora (rs=0.36; p<0.05). The detection rate of opportunistic flora was also correlated with BMI (rs=0.33; p<0.05).

Table 2

Hormonal profile of the examined women

Indicator		Group I (n=11)	Group II (n=13)	Group III (n=10)
LH, mIU/ml	Phase I	4.3±0.2	4.9±0.2	4.6±0.4
		3.0–5.6	3.5–6.3	2.1–7.1
	Phase II	2.8±0.2	3.1±0.3	2.6±0.3
		1.5–4.3	1.0–5.2	1.6–3.6
FSH, mIU/ml	Phase I	6.8±0.3	6.6±0.2	7.0±0.5
		4.9–8.7	5.2–8.0	6.0–9.0
	Phase II	4.6±0.3	4.9±0.3	4.4±0.4
		2.7–6.5	3.8–7.1	1.9–6.9
Estradiol, pg/ml	Phase I	78±5	89±8	99±6
		45–111	42–145	62–136
	Phase II	112±9	103±11	134±28
		53–171	25–181	1–308
Progesterone, pg/ml	Phase I	0.6±0.1	0.7±0.1	0.7±0.1
		0.1–1.3	0.1–1.4	0.1–1.4
	Phase II	2.9±0.1	3.1±0.1	2.6±0.2
		2.2–3.6	2.4–3.8	1.9–3.3
Prolactin, ng/ml		8.5±0.3	6.4±0.2	8.5±0.2
		6.6–10.4	5.0–7.8	7.1–9.9
Testosterone, nmol/l		0.8±0.1	0.9±0.1	0.7±0.1
		0.1–1.5	0.2–1.6	0.1–1.4
Leptin, ng/ml		5.3±0.3	6.4±0.4	9.2±0.7*
		3.4–7.2	3.6–9.2	4.9–13.5

*Note: * – differences with other groups are statistically significant (p<0.05).*

Table 3

Composition of the hypogastric skin microbiota in the examined women

Type of microorganisms	Group I (n=11)		Group II (n=13)		Group III (n=10)	
	Abs.	%	Abs.	%	Abs.	%
Lactobacillus	3	27.3	1	7.7	–	–
Corynebacterium	7	63.6	10	76.9	9	90.0
Paenibacillus	2	18.2	4	30.8	5	50.0*
Prevotella	3	27.3	3	23.1	3	30.0
E. coli	1	9.1	3	23.1	4	40.0*
Enterococci spp.	1	9.1	1	7.7	3	30.0
Klebsiella	10	90.9	13	100	9	90.0
Propionibacteriae	11	100	11	84.6	8	80.0
Malassezia spp.	1	9.1	1	7.7	2	20.0
St. aureus	1	9.1	1	7.7	1	10.0
Str. epidermitidis	1	9.1	2	15.4	3	30.0*

*Note: * – differences with other groups are statistically significant (p<0.05).*

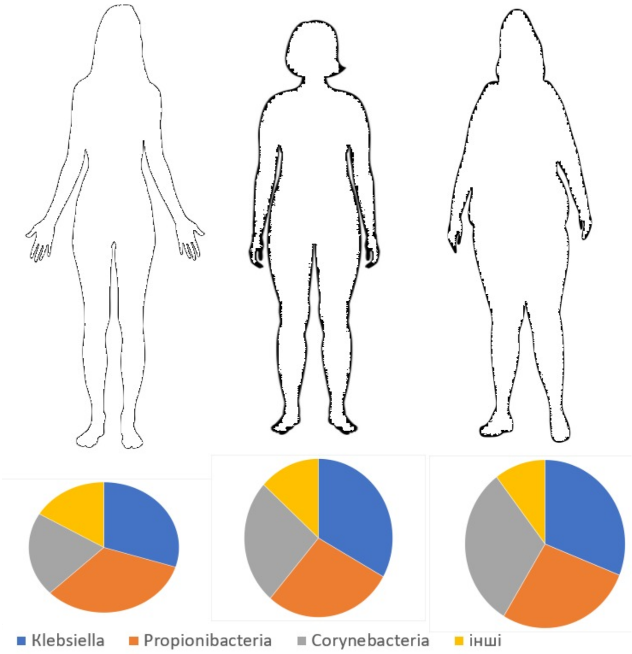

Fig. 1. Structure of microbiocenoses in women with different BMIs

The skin microbiome is determined at birth [7]. Subsequently, throughout life, it changes under the influence of both internal and external factors. Obese women experience changes in their hormonal profile, which contribute to the development of opportunistic pathogens. In addition, fat folds contribute to the accumulation of sebum, which also affects the microbial landscape.

Among the estrogen metabolites, 17β-estradiol is the most important, as it activates antioxidant and antiapoptotic effects via ERβ. At the same time, the skin becomes more elastic, performs a better barrier function, increases skin hydration and intensifies local blood flow. The production of sebum, collagen, elastin, cholecalciferol, and antioxidants increases. There is evidence that in obese women, the formation of 17β-estradiol decreases, while the total amount of estrogen increases due to increased aromatization of androgens. This could theoretically affect wound healing. Regarding the qualitative composition of hypogastric skin microbiocenosis, it is unlikely that the changes we identified in women with metabolic syndrome and obesity can significantly affect the risk of postoperative complications.

Firstly, the surgical field is subject to antiseptic treatment, which levels the value of the initial composition of the microbiocenosis. Secondly, the main source of infection during laparotomy for pelvic purulent and inflammatory processes can be directly pathological altered tissues.

In our study, there were no cases of postoperative purulent-septic complications. On 3 July 1909, at the age of 47, Hermann Johannes Pfannenstiel died. The Berlin gynaecologist, who gave his name to the widespread low transverse incision, died of septicemia 1 week after a surgical needle pricked his left middle finger, which was obtained during surgery on a patient with a tubo-ovarian abscess [1]. Such cases were not uncommon in the early days of abdominal surgery.

With the advent of antibiotics, postoperative infections no longer pose such a danger to patients or surgeons themselves, but are still quite common, potentially life-threatening and costly for national healthcare systems [15, 16].

Currently, the following preventive approaches are used in obstetrics and gynecology as a part of the infection control system:

– Prophylactic antibiotics significantly reduce infectious morbidity after hysterectomy and pregnancy termination.

– Vaginal hysterectomy is associated with less infectious morbidity than total abdominal hysterectomy, but antibiotic prophylaxis is necessary for all hysterectomies.

– Consensus guidelines also recommend antibiotic prophylaxis for other invasive procedures and interventions.

– Antibiotic prophylaxis for hysterectomy should be broad-spectrum, including anti-anaerobic agents for the treatment of wound infection and urinary tract infection, perivaginal cuff infection, and pelvic infections (e.g., 1 g metronidazole before surgery plus 750 mg cefuroxime intravenously with induction of anesthesia or 1.2 g co-amoxiclav with induction of anesthesia).

The risk of infectious complications is influenced by systemic factors, including obesity, diabetes, advanced age, lung disease, malignancy, and steroid use [4, 11, 15, 16]. Proper surgical technique in these patients is particularly important, as any technical error increases the risk of wound infection. It is widely believed that transverse incisions are associated with a lower incidence of postoperative ventral hernia and infectious complications than midline laparotomy. Given the absence of morbidly obese women among the study population, the technical aspect of the incisions is of secondary importance. More important is the qualitative composition of the skin microbiocenosis at the incision site and the adequacy of the antiseptic used for the intervention.

Conclusions. 1. Qualitative composition of hypogastric skin microbiocenosis depends on nutritional status.

2. A medium strength correlation between estradiol content and the detection of opportunistic pathogens was found ($r_s=0.36$; $p<0.05$). The detection rate of opportunistic bacteria is also correlated with BMI ($r_s=0.33$; $p<0.05$).

3. The impact of the qualitative composition of hypogastric skin microbiocenoses on the risk of postoperative infectious complications is inconclusive.

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