Bosphorus Medical Journal
Boğaziçi Tıp Dergisi

Original Article

DOI: 10.14744/bmj.2023.28247

Bosphorus Med J 2023;10(1):40–44

The Relationship Between Homeostatic Model Assessment Insulin Resistance (HOMA-IR) Values and Pilonidal Sinus Disease in Female Adolescents: A Retrospective Study

Adolesan kızlarda Homeostatic Model Assessment Insulin Resistance (HOMA-IR) Değerleri ile Pilonidal Sinüs Hastalığı Arasındaki İlişki: Retrospektif Bir Çalışma

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Cite this article as:
Harma B. Relationship Between Homeostatic Model Assessment Insulin Resistance (HOMA-IR) Scores and Pilonidal Sinus Disease in Female Adolescents: A Retrospective Study. Bosphorus Med J 2023;10(1):40–44.

Received: 15.01.2023
Revision: 14.02.2023
Accepted: 02.03.2023

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ABSTRACT

Objectives: Pilonidal sinus is a subcutaneous inflammatory disease most commonly seen in the sacrococcygeal region and is more common in boys. It is seen earlier in women because of the earlier onset of puberty and activation of sex hormones during this period. To the best of our knowledge there is a very limited research regarding the interrelation of insulin resistance levels and plonidal sinus disease (PSD). This study aims to determine the role of insulin resistance on the development of pilonidal sinus disease in female adolescents.

Methods: This retrospective study includes a patient group of 30 adolescent girls who were operated for PSD and a control group created from the hospital records with the same number. Free T3, T4, TSH, insulin and fasting blood sugar levels were recorded from the hospital data-base. Homeostasis model assessment of insulin resistance (HOMA-IR) score was calculated to describe the insulin resistance. Insulin resistance was defined when HOMA-IR score ≥ 2.86 in adolescents.

Results: The median age of the patients was 15.83±1.86 years and twenty-five of them (%83.3) were accepted to be insulin resistant. According to our findings the levels of thyroid function tests (free T3, free T4, and TSH) did not vary substantially between patient and control groups ($p>0.05$). A strong correlation was found between PSD and high insulin (mean±SD 19.46±7.28; $p<0.05$) and HOMA-IR score (mean±SD 4.59±1.87; $p<0.05$).

Conclusion: According to the correlation analysis of HOMA-IR scores and insulin levels it is concluded that high insulin level with elevated HOMA-IR score may cause excessive hair growth by means of hormonal pathways. Therefore hyperinsulinemia is a risk factor for the development of PSD in female adolescents.

Keywords: HOMA-IR score; insulin; pilonidal sinus disease.

ÖZET

Amaç: Pilonidal sinüs büyük sıklıkla sakrokoksigeal bölgede görülen cilt altı inflamatuar bir hastalıktır ve erkeklerde daha sık görülür. Kadınlarda daha erken görülmesinin nedeni, ergenliğin erken başlaması ve bu dönemde seks hormonlarının aktivasyonudur. Bildiğimiz kadarıyla insulin direnci seviyesi ve pilonidal sinüs hastalığı (PSH) arasındaki ilişki hakkında çok sınırlı araştırma bulunmaktadır. Bu çalışma adolesan kız çocuklarda pilonidal sinüs hastalığı (PSH) gelişiminde insülin direncinin rolünü belirlemek için yapılmıştır.

Yöntem: Bu retrospektif çalışma PSH nedeniyle ameliyat edilen 30 adölesan kızdan oluşan bir hasta grubunu ve hastane kayıtlarından aynı sayıda oluşturulan bir kontrol grubunu içermektedir. Serbest T3, T4, TSH, insülin ve

açlık kan şekeri düzeyleri hastane veri tabanından kaydedildi. İnsülin direncini tanımlamak için insülin direncinin homeostaz modeli değerlendirmesi (HOMA-IR) indeksleri hesaplandı. HOMA-IR skoru ≥2.86 olan ergen çocuklarda insülin direncinin varlığı kabul edildi.

Bulgular: Hastaların ortanca yaşı 15,83±1,86 yıl olarak bulundu ve bunların 25'inde (%83.3) insülin direnci saptandı. Tiroid fonksiyon testleri (serbest T3, serbest T4 ve TSH) hasta ve kontrol grupları arasında önemli farklılık göstermedi (p>0,05). PSH ile yüksek insülin (ortanca±SS 19.46±7.28; p<0.05) ve HOMA-IR skoru (ortanca±SS 4.59±1.87; p <0.05) arasında güçlü bir korelasyon bulundu.

Sonuç: HOMA-IR skorları ile insülin düzeylerinin korelasyon analizine göre, yüksek HOMA-IR skoru ile yüksek insülin seviyesinin hormonal yollarla aşırı tüy büyümesine neden olabileceği sonucuna varılmıştır. Bu nedenle hiperinsülinemi, kız ergenlerde PSD gelişimi için bir risk faktörüdür.

Anahtar sözcükler: HOMA-IR skoru; insülin; pilonidal sinüs hastalığı.

Pilonidal sinus is a subcutaneous inflammatory disease that mainly affects young patients. It is most commonly seen in the sacrococcygeal region and in the second decade of life.[1] The reason why it is more common 3 to 4 times more frequently in boys is explained by the fact that they have a more hairy structure and the hair follicles are harder. However, it is seen earlier in women because of the earlier onset of puberty and activation of sex hormones during this period sinus.[2-4] According to the acquired theories, pilonidal sinüs disease (PSD) occurs during puberty, when sex hormones begin to act on the pilosebaceous glands in the natal cleft. A hair follicle becomes filled with keratin and then becomes infected, and this infection spreads to the subcutaneous fat tissue, forming a tract. The hairs around this tract pierce the skin while their roots are still attached, and after the hairs are shed, they are absorbed deeper by the movements of the gluteus maximus muscles. Often the hairs are entrained with pathogenic microorganisms.[5]

In a study about the link between pilonidal sinus and obesity, it was reported that individuals with PSD were more likely to be overweight individuals.[6] Obesity is the source of insulin resistance, complicated cellular condition affecting several organ systems and leading to severe metabolic disorders.[7,8] Many patients with severe insulin resistance do not have apparent diabetes, but most of them may have acanthosis nigricans, alopecia, signs of autoimmune disease, ovarian-induced hyperandrogenism, amenorrhea, hirsutism, growth and development disorders, and obesity.[9] Increased insulin level causes a decrease in androgen (testosterone) production in the ovaries and SHBG (sex hormone binding globulin) of the liver as well. Decreased SHBG results in raised androgen levels which causes hirsutism, acne and obesity.[10,11] Lack or excess of thyroid hormones has a significant influence on the homeostasis of glucose. Diabetes, hyperinsulinemia, impaired peripheral glucose clearance, and insulin resistance are all related to glucose and insulin metabolism that have been linked to hypothyroidism.[12-15] To the best of our knowledge there is very limited literature regarding the interrelation of obesity, hirsutism and PSD in the related literature. In this retrospective study we aimed to evaluate the effect of obesity and hirsutism on the development of pilonidal sinus disease in adolesence girls.

Methods

This retrospective study includes a patient group consisting of 30 adolescent girls who were operated for PSD between January 2021 and November 2022 and a control group which was created from the hospital records with the same number. In both groups, children who have a history or known any hematological or metabolic disease or using regular medication were excluded. Demographic and clinical data were recorded for all cases by creating a data list. Laboratory tests and pathology reports were downloaded from the medical registry system of Malatya Training and Research Hospital. Biochemical tests and hemograms were obtained by Abbott Architect c16000 (Illinois, USA) and Sysmex Corporation XN-10 (Kobe, Japan), respectively. Free T3, T4, TSH, insulin and fasting blood sugar levels were recorded. Homeostasis model assessment of insulin resistance (HOMA-IR) values was calculated to describe the insulin resistance.[16] Following 8 to10 hours of fasting, the blood sugar(mg/dL) and insulin level(μU/mL) are multiplied by each other and divided by 405 according to this calculation.[17] According to proposed calculation children whose score was higher then the cut-off value were defined as insulin resistant. This retrospective study was approved by the Institutional Ethics Review Board for Clinical Research (2022/234).

Statistical Analysis

The Shapiro-Wilk test was used to determine if the quantitative data had a normal distribution. The data that did not show normal distribution were summarized as the median and interquartile range (IQR), and data with normal distribution were summarized as mean±standard deviation. Mann-Whitney-U test and independent sample t-test were used where appropriate for statistical analysis. Relationships between variables were analyzed with the Spearman correlation coefficient. Cut-off points for quantitative variables were determined by ROC (Receiver operation characteristics) analysis. Optimal cut-off points for numerical data were determined according to the Youden Index. The $p<0.05$ value was considered statistically significant in the applied statistical analyzes. American Psychological Association (APA) 6.0 style was used to report statistical differences . All analyzes were performed using IBM SPSS Statistics 28.0 for Windows (New York; USA).[18]

Results

There was no statistically significant difference between the patient and control groups according to age ($p>0.05$, Table 1). The mean age of the patients was 15.83±1.86 years (range 10-18 years), and, it was 15.07±2.24 years in the control group.

According to the research findings; There were a statistically significant difference between the groups for insulin and HOMA-IR score ($p<0.05$). On the other hand, no statistically significant difference was found between the groups for the other analyzed age, glucose, T3, T4, and TSH variables ($p>0.05$). Insulin value was significantly higher in the patient group than in the control group (Mean±SD 19.46±7.28), and HOMA-IR score was similarly higher in the patient group than in the control group (Mean±SD 4.59±1.87).

According to the ROC analysis results, insulin and HOMA-IR score were found to be distinguishing parameters for pilonidal sinus disease ($p<0.05$). The values calculated from the ROC curve for glucose, T3, T4 and TSH variables were not statistically significant ($p>0.05$). Among these variables, it was observed that the parameter with the highest AUC value belonged to insulin and HOMA-IR. As a result of the ROC analysis for insulin, the cut-off point was 12.15, corresponding to the highest sensitivity and specificity point. At this point, the sensitivity of the scale was found to be 0.833 and the specificity was determined as 0.767. (Table 2-3, Fig. 1). The variable with the highest AUC value after insulin was HOMA-IR score. At a cut-off value of 2.86, the sensitivity of the HOMA-IR score was 0.867, and the specificity was 0.767 (Table 4-5, Fig. 2).

Discussion

Pilonidal sinus disease starts with puberty, when sex hormones begin to act on pilosebaceous glands in the natal cleft. Hair follicles become distended with the filling of keratin and subsequently infected, leading to folliculitis and abscess formation that invade the subcutaneous fat tissue.[19] Although the incidence is unknown, PSD in women is rare and the affected girls were younger than the boys, because of the earlier onset of puberty in females.[20] It is known that the sex hormones produced first at puberty affect the pilosebaceous glands, which coincides with the earliest onset of PSD.[3]

Table 1. Descriptive statistics for numerical variables in terms of group

Variable	Group				p
	Control		Patient		
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
Age (y)	15.07±2.24	15[a] (3)	15.83±1.86	16[a] (2)	0.179*
Glucose (mg/dL)	92.07[a]±5.09	91 (8)	93.07[a]±6.15	93 (8)	0.496**
T3 (pg/mL)	3.96[a]±0.71	4.04 (0.71)	3.79[a]±0.83	3.745 (0.66)	0.397**
T4 (ng/mL)	1.31±0.22	1.315[a] (0.31)	1.44±0.87	1.26[a] (0.17)	0.796*
TSH (mU/L)	1.89±0.86	1.72[a] (0.88)	2.43±1.3	2.165[a] (1.33)	0.117*
İnsulin (uU/ml)	10.3±4.59	9.235[a] (4.64)	19.46±7.28	18.545[b] (11.71)	<0.001*
HOMA-IR	2.31[a]±1.01	2.18 (1.22)	4.59[b]±1.87	4.085 (2.96)	<0.001**

*: Mann Whitney U test; **: Independent sample t-test; SD: Standard deviation; IQR: interquartile range, [a, b]: There is a statistically significant difference in group categories that do not contain the same letter in each row.

Table 2. Area Under the Curve (AUC) of insulin

AUC	%95 Confidence Interval	z-Test	p
0.868	(0.775-0.96)	7.805	<0.001

Table 3. Cut-off Statistics of insulin

(Youden Index)	Cut-Off	Sensitivity	Specificity
0.6	12.155	0.833	0.767

Table 4. Area Under the Curve (AUC) of HOMA-IR scores

AUC	%95 Confidence Interval	z-Test	p
0.877	(0.788-0.966)	8.325	<0.001

Table 5. Cutoff Statistics of HOMA-IR scores

Youden Index	Cut-Off	Sensitivity	Specificity
0.633	2.865	0.867	0.767

The growth of sexual hair depends on the presence of androgen. The form of hair is vellus (small, straight, and fair) before puberty, and the androgen-sensitive follicles, which contain sebaceous glands are small. At puberty, vellus follicles transform into terminal hairs (larger, curlier, and darker, hence more visible) by increased androgens.[21] In addition to hyperandrogenism, excess hair growth is influenced by familial or ethnic variables and by some disorders, including altered corticosteroid or thyroid hormone metabolism.[22–24] In this study, the levels of thyroid function tests (free T3, free T4, and TSH) did not vary substantially between patient and control groups (p>0.05). Conversely, a strong correlation was found between PSD and elevated fasting insulin levels and HOMA-IR scores as well. (p<0.05, Table 1).

HOMA scores of more than 2.86, which indicates insulin resistance, were found in 23 (77%) and 5 (16%) children in patient and control groups, respectively, and the difference was statistically significant (p<0.001). It is believed that insulin may contribute to local androgen production from cholesterol or convert weak androgens into more potent androgens.[25] Insulin also seems to be one of the factors that interact with androgen to regulate pilosebaceous unit development.[26] Since IGF-1 and insulin are similar peptide hormones, insulin can cross-react with IGF-1 receptors.[27] Thus, it is thought that hyperinsulinism may increase 5α-reductase activity in the skin, thereby increasing the conversion of testosterone to DHT, which is responsible for follicle miniaturization.[28] In conclusion according to the correlation analysis of HOMA-IR scores and insulin levels, high insulin level with elevated HOMA-IR score may cause excessive hair growth by means of hormonal pathways which is a risk factor for the development of PSD in female adolescents.

The limitations of this study is the lack of oral glucose tolerance test, quantitative insulin sensitivity check index and oral glucose tolerance test or the lack of body-mass indexes in order to diagnose the obesity. Although its retrospective design is the main limitation, the results that obtained from this study may serve a perspective for the future prospective studies focusing on this subject.

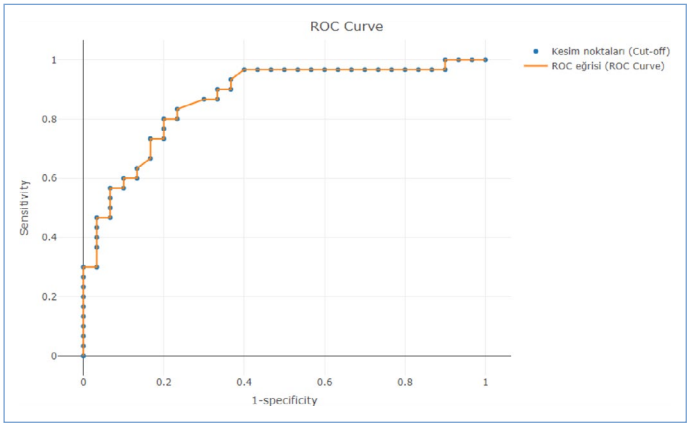

Figure 1. The cut-off point of the insulin variable for the group.

The area under the ROC curve differs significantly from 0.5 and therefore, the new test can distinguish between the two groups.

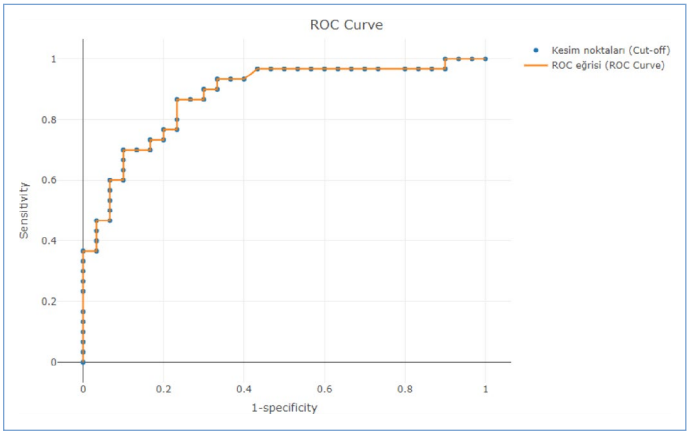

Figure 2. The cut-off point of the HOMA-IR variable in terms of the group.

The area under the ROC curve differs significantly from 0.5 and therefore, the new test can distinguish between the two groups.

Disclosures

Ethics Committee Approval: The study was started after the approval of Malatya Turgut Özal University Faculty of Medicine Non-Invasive Ethics Committee. (Date: 27.12.2022, Decision No: 2022/234).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

References

1. da Silva JH. Pilonidal cyst: Cause and treatment. Dis Colon Rectum 2000;43:1146–56.
2. Brearley R. Pilonidal sinus; A new theory of origin. Br J Surg 1955;43:62–8.
3. Price ML, Griffiths WA. Normal body hair--a review. Clin Exp Dermatol 1985;10:87–97.
4. Millar DM. Etiology of post-anal pilonidal disease. Proc R Soc Med 1970;63:1263–4.
5. Eryilmaz R, Sahin M, Okan I, Alimoglu O, Somay A. Umbilical pilonidal sinus disease: Predisposing factors and treatment. World J Surg 2005;29:1158–60.
6. Franckowiak JJ, Jackman RJ. The etiology of pilonidal sinus. Dis Colon Rectum 1962;5:28–36.
7. Rachoń D, Teede H. Ovarian function and obesity--interrelationship, impact on women's reproductive lifespan and treatment options. Mol Cell Endocrinol 2010;316:172–9.
8. Altunoğlu EG. Insulin resistance. İstanbul Med J 2012;13:137–40.
9. Murat B. Pre-Diyaliz, hemodiyaliz ve sürekli ayaktan periton diyalizi hastalarında insülin direncinin karşılaştırılması. Uzmanlık Tezi. İstanbul: T.C. Haydarpaşa Numune Eğitim ve Araştırma Hastanesi 2. dahiliye kliniği; 2004.
10. Trivax B, Azziz R. Diagnosis of polycystic ovary syndrome. Clin Obstet Gynecol 2007;50:168–77.
11. Karrer-Voegeli S, Rey F, Reymond MJ, Meuwly JY, Gaillard RC, Gomez F. Androgen dependence of hirsutism, acne, and alopecia in women: Retrospective analysis of 228 patients investigated for hyperandrogenism. Medicine (Baltimore) 2009;88:32–45.
12. Peppa M, Koliaki C, Nikolopoulos P, Raptis SA. Skeletal muscle insulin resistance in endocrine disease. J Biomed Biotechnol 2010;2010:527850.
13. Muscogiuri G, Sorice GP, Mezza T, Prioletta A, Lassandro AP, Pirronti T, et al. High-normal TSH values in obesity: Is it insulin resistance or adipose tissue's guilt? Obesity (Silver Spring) 2013;21:101–6.
14. Maratou E, Hadjidakis DJ, Kollias A, Tsegka K, Peppa M, Alevizaki M, et al. Studies of insulin resistance in patients with clinical and subclinical hypothyroidism. Eur J Endocrinol 2009;160:785–90.
15. Dimitriadis G, Mitrou P, Lambadiari V, Boutati E, Maratou E, Panagiotakos DB, et al. Insulin action in adipose tissue and muscle in hypothyroidism. J Clin Endocrinol Metab 2006;91:4930–7.
16. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: Insulin resistance and beta-cell function from fasting plasma glucose and insulin concentrations in man. Diabetologia 1985;28:412–9.
17. Keskin M, Kurtoglu S, Kendirci M, Atabek ME, Yazici C. Homeostasis model assessment is more reliable than the fasting glucose/insulin ratio and quantitative insulin sensitivity check index for assessing insulin resistance among obese children and adolescents. Pediatrics 2005;115:e500–3.
18. Arslan AK, Yaşar S, Çolak C, Yoloğlu S. WSSPAS: An interactive web application for sample size and power analysis with R using shiny. Turkiye Klin J Biostat 2018;10:224–46.
19. Jones DJ. ABC of colorectal diseases. Pilonidal sinus. BMJ 1992;305:410–2.
20. Serour F, Somekh E, Krutman B, Gorenstein A. Excision with primary closure and suction drainage for pilonidal sinus in adolescent patients. Pediatr Surg Int 2002;18:159–61.
21. Rosenfield RL. Clinical practice. Hirsutism. N Engl J Med 2005;353:2578–88.
22. Comaish JS. The thyroid and hair growth. Semin Dermatol 1985;4:4–8.
23. Blok GJ, de Boer H, Gooren LJ, van der Veen EA. Growth hormone substitution in adult growth hormone-deficient men augments androgen effects on the skin. Clin Endocrinol (Oxf) 1997;47:29–36.
24. Azziz R, Carmina E, Sawaya ME. Idiopathic hirsutism. Endocr Rev 2000;21:347–62.
25. Abdel Fattah NS, Darwish YW. Androgenetic alopecia and insulin resistance: Are they truly associated? Int J Dermatol 2011;50:417–22.
26. Rosenfield RL. Polycystic ovary syndrome and insulin-resistant hyperinsulinemia. J Am Acad Dermatol 2001;45(Suppl 3):S95–104.
27. Boucher J, Tseng YH, Kahn CR. Insulin and insulin-like growth factor-1 receptors act as ligand-specific amplitude modulators of a common pathway regulating gene transcription. J Biol Chem 2010;285:17235–45.
28. Yi SM, Son SW, Lee KG, Kim SH, Lee SK, Cho ER, et al. Gender-specific association of androgenetic alopecia with metabolic syndrome in a middle-aged Korean population. Br J Dermatol 2012;167:306–13.