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INFLUENȚA MOBILIZĂRII PASIVE CONTINUE ÎN REDUCEREA DURERII ȘI A MOBILITĂȚII GENUNCHIULUI PROTEZAT

THE INFLUENCE OF CONTINUOUS PASSIVE MOBILIZATION IN REDUCING PAIN AND MOBILITY IN THE PROSTHETIC KNEE

Emilian Tarcău[1], Diana-Simona Bochiș[1], Ioan-Cosmin Boca[2]

Abstract

The increasing incidence of trauma to the knees determines the premises of a subsequent osteoarthritis, which is why the prevalence of knee prosthesis has increased significantly lately. The study was based on the hypothesis that continuous passive mobilization included in the recovery protocol after total knee arthroplasty will reduce pain, increase amplitude of knee flexion and reduce the deficit of knee extension. The study included 2 groups of patients who benefited from the same recovery protocol, the experimental group also having continuous passive mobilization. At the end of the study, the hypothesis was refuted, there being no concrete link between continuous passive mobilization and pain reduction along with increases in mobility in the knee joint, compared to classical physical therapy.

Key words: *continuous passive mobilization, knee, arthritis*

Rezumat

Incidența din ce în ce mai ridicată a traumatismelor de la nivelul genunchilor, determină premisele unei gonartroze ulterioare, motiv pentru care prevalența protezării genunchiului a crescut simțitor în ultimul timp. În realizarea studiului s-a plecat de la ipoteza conform căreia mobilizarea pasivă continuă inclusă în protocolul de recuperare după artroplastia totală de genunchi va duce la scăderea durerii, câștigarea unei amplitudini mai mari de flexie de genunchi și reducerea deficitului de extensie a genunchiului. Au fost incluse în studiu 2 loturi de pacienți care au beneficiat de același protocol de recuperare, lotul experimental având în plus și de mobilizare pasivă continuă. La finalul studiului, ipoteza a fost infirmată, neexistând nicio legătură concretă între mobilizarea pasivă continuă și reducerea durerii alături de creșteri de mobilitate în articulația genunchiului, față de kinetoterapia clasică.

Cuvinte cheie: *mobilizare pasivă continuă, genunchi, artroză*

Introducere

Traumatismele pot fi o cauză de artroză, mai ales, dacă sunt repetate sau dacă determină leziuni majore ale elementelor constitutive ale articulaţiei [1]. Cele mai frecvent întâlnite artroze,

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sunt localizate la nivelul articulațiilor mâinii, regiunii cervicale, genunchilor (gonartroza) și șoldurilor (coxartroza).

La nivelul genunchiului, gonartroza este rezultatul unui dezechilibru funcţional între rezistenţa structurilor articulare şi tensiunile la care acestea sunt supuse. [1]

Conform datelor OMS (1994), gonartroza este o raritate la persoanele de pană la 35 ani, pe când la persoanele de după 70 de ani, se constată schimbări radiografice în 20-40% din cazuri, cu manifestări clinice în 30% [5]. La femei, incidenţa gonartrozei este de 2 ori mai mare înaltă decât la bărbaţi. După gradul de distrucţie articulară şi cel de invalidizare, gonartroza se situează pe locul II, după coxartroză.

Gonartroza, afecțiune degenerativă a cartilajului articular are o plurietiologie (rezultatul este același, dar factorii patogeni sunt diferiți). În gonartroză poate fi distrus compartimentul intern, cel extern, ambele compartimente sau ambele împreună cu suprafața patelară. [3]

Pe baza examenului clinic, radiologic și artroscopic, Ministerul Sănătății, Muncii și Protecției Sociale al Republicii Moldova [13], realizează un protocol clinic național privind reabilitarea medicală a bolnavului cu gonartroză și stadializează această afecțiune astfel:

- Stadiul 1 – clinic: durere minimă, uneori cu redoare matinală și/sau inflamație locală (edem și tumefacție) – radiologic: fără modificări la nivelul articulației - artroscopic: cu semne ale degenerării cartilajului (cartilaj moale și opac)
- Stadiul 2 – clinic: durere de intensitate medie, redoare articulară matinală importantă, semne de inflamație locală - radiologic: îngustarea spațiului articular - artroscopic: fibrilarea cartilajului și degenerarea meniscului
- Stadiul 3 – clinic: durere moderată permanent, redoare matinală și după repaus semnificativă, limitarea mobilității articulare, cracmente osoase la mișcări de flexie/extensie - radiologic:îngustarea spațiului articular, osteofite marginale, modificarea axului biomecanic al membrului inferior - artroscopic: fragmentarea cartilajului articular, corpi liberi intraarticulari, leziuni degenerative ale meniscului
- Stadiul 4 – clinic: durere intraarticulară intensă, insuportabilă, apare în repaus, în timpul nopții, la schimbarea vremii, nu mai răspunde la medicația analgezică, antiinflamatoare, deformarea articulară, instabilitatea articulară - radiologic: îngustarea până la dispariție a spațiului articular, osteofite marginale, scleroza osoasă, dezalinierea structurilor osoase - artroscopic: absența cartilajului articular pe porțiuni întinse.

Conform acestei clasificări, este limpede că în stadiile avansate ale gonartrozei (3 și mai ales 4), se impune intervenția chirurgicală și de cele mai multe ori realizarea unei artroplastii totale de genunchi. Într-o astfel de intervenție chirurgicală majoră, cum este artroplastia totală de genunchi, imediat după incizie, apare un răspuns complex neurohormonal, imunologic şi metabolic, a cărui magnitudine este direct proporțional cu amploarea injuriei tisulare, timpul total operator, pierderile de sânge, alegerea tehnicii anestezice, durerea postoperatorie, etc. [12] La pacienții aflați într-un stadiu avansat de modificări degenerative care compromit cartilajul articular, afectând mai multe compartimente ale genunchiului, literatura de specialitate nu a identificat încă o opțiune alternativă trainică privind regenerarea cartilajului. În acest fel, intervenția de înlocuire totală de genunchi s-a demonstrat a fi reproductibilă, durabilă, având rezultate de succes în vederea reducerii durerii și îmbunătățiri calității generale a vieții. [7]

Timpul de recuperare în proteza de genunchi depinde, în mare măsură, de tipul și rigurozitatea intervenției fizio- și kinetoterapeutice pre și postoperatorie. Una dintre controverse, în acest caz, o reprezintă introducerea sau nu a dispozitivului de mobilizare pasivă continuă cât mai precoce postoperator, și care ar fi beneficiile acestei intervenții în ceea ce privește reducerea intensității durerii și refacerea mobilității articulare.

Unii autori consideră că ”mobilizarea pasivă continuă postoperatorie pompează sângele și reduce edemul, asigurând astfel accelerarea procesului de vindecare a țesutului periarticular. Pe lângă beneficiile trofice, tehnica este folosită în recuperare pentru a reduce durerea și pentru a câștiga sau a păstra mobilitatea articulară” [11].

Alții spun că deși ”în ultimii 25 de ani, mișcarea pasivă continuă este prezentă în dezbaterile clinice datorită implicațiilor ei în faza de recuperare după proteza totală de genunchi, totuși, mobilizarea pasivă continuă rămâne un subiect controversat, unele studii subliniind chiar lipsa beneficiilor tehnicii în comparație cu kinetoterapia.” [8]

Material și metodă

Studiul s-a desfășurat în spitalul Clinalliance Villiers-sur-Orge, Franța în perioada februarie – aprilie 2020. Au fost constituite două loturi de pacienți:

1. Grupul de control, compus din 6 pacienți, 50% femei și 50% bărbați, cu media de vârstă de 75,166 de ani±9,325;
2. Grupul experimental, compus din 3 pacienți, 66,66% femei și 33,33% bărbați, cu media de vârstă de 67,33±5,131 ani.

Pacienții din ambele loturi au artroplastie totală de genunchi. Recuperarea a început la 10 zile după operație. Au beneficiat de 3 săptămâni de kinetoterapie, 5 zile/săptămână de luni până vineri, 100 de minute/zi, adică 2 ședințe a câte 50 de minute pe zi.

Protocolul de recuperare este identic pentru cele două grupuri, exceptând mobilizarea pasivă continuă, care este utilizată doar în cazul grupului experimental. Ambele grupuri au beneficiat de aplicații de gheață timp de 15 minute la sfârșitul fiecărei ședințe.

Tabelul 1. Prezentarea pacienților

Nr.crt.	*Subiecți*	*Vârstă*	*Gen*	*Diagnostic*
Lot experimental				
1.	**C.J.**	73	M	Artroplastie totală genunchi drept după gonartroză operată în 06/03/20
2.	**D.E.**	66	F	Artroplastie totală genunchi stâng după gonartroză operată în 04/03/20
3.	**M.B.**	63	F	Artroplastie totală genunchi drept după gonartroză operată în 02/03/20
Lot de control				
1	**J.C.**	82	M	Artroplastie totală genunchi drept după gonartroză operată în 28/02/20
2	**Y.N.**	71	M	Artroplastie totală genunchi drept după gonartroză operată în 26/02/20
3	**P.N.**	61	F	Artroplastie totală genunchi stâng după gonartroză operată în 18/02/20
4	**P.L.**	70	M	Artroplastie totală genunchi drept după gonartroză operată în 11/02/20
5	**J.C.**	85	F	Artroplastie totală genunchi stâng după gonartroză operată în 17/02/20
6	**C.F.**	82	F	Artroplastie totală genunchi stâng după gonartroză operată în 17/02/20

Pacienții care au participat la studiu au posibile operații anterioare (proteză totală de genunchi la celălalt membru inferior, proteză de șold), dar mai vechi de un an minim. Pacienții nu prezentau boli care pot afecta procesul de evaluare, cum ar fi: probleme cognitive, probleme de înțelegere, barieră lingvistică, boli neurodegenerative.

Ipoteza

În realizarea studiului plecăm de la ipoteza conform căreia mobilizarea pasivă continuă, inclusă în protocolul de recuperare după artroplastia totală de genunchi poate duce la scăderea durerii, câştigarea unei amplitudini mai mari de flexie a genunchiului şi la reducerea deficitului de extensie a genunchiului.

Metode de evaluare utilizate

Evaluarea durerii – a fost realizată cu ajutorul scalei VAS (scala vizuală analogă), care constă în aprecierea intensității durerii pe o scală de la 0 la 10, în care numărul 0 înseamnă ”fără durere” și numărul 10 ”durere foarte puternică, maximă”.

Pentru realizarea ei, pacientul are în mână o riglă cu un cursor ce va fi poziționat de pacient la nivelul pe care îl identifică ca fiind egal cu intensitatea durerii resimțită. Evaluarea a fost efectuată în 2 momente diferite, în repaus și în activitate, atât inițial - la prima ședință de kinetoterapie, cât și final- la ultima ședință.

Mobilitatea genunchiului – a fost evaluată cu ajutorul goniometrului pe mișcările de flexie și extensie a genunchiului, atât pasiv, cât și activ.

Protocolul de recuperare

Pacientul începe ședințele de kinetoterapie din ziua 2 de spitalizare. Recomandările avute în evidență în formarea programului de recuperare sunt:

Ziua 1

- ✓ Lucru la distanță: se solicită flexia și extensia activă a gleznei;
- ✓ Se lucrează static cvadricepsul și ischiobambierii în decubit dorsal cu genunchiul întins;
- ✓ Se mobilizează rotula;
- ✓ Se lucrează flexia genunchiului în pasiv, pasivo-activ/activo-pasiv manual sau folosing aparatura creată în acest scop;
- ✓ Pacientul trebuie să ajungă la o flexie a genunchiului de 90 de grade până în ziua 10 de recuperare;
- ✓ Se folosește mobilizarea pasivă continuă 30 de minute de zi (pentru grupul experimental). Aplitudinea setată este amplitudinea la care s-a ajuns prin mobilizarea manuală cu un nivel de durere suportabil;
- ✓ La sfârșitul fiecărei ședințe, pacienților li se aplică gheață pentru 15 minute.

Ziua 2

- ✓ Se începe lucrul în dinamic a cvadricepsului. Se realizează contracții concentrice pe pe ultimele 20 de grade de extensie plasând un prosop/cearșaf îndoit în zona poplitee;
- ✓ Se lucrează transferul din scaunul cu rotile în pat și invers;
- ✓ Se începe mersul cu ajutorul echipamentelor ortopedice (cadru de mers, cârje);
- ✓ Este necesară obținerea unei flexii între 50° și 70°.

Ziua 3

- ✓ Se introduce în programul de recuperarea posturarea genunchiului în extensie: pacientul în așezat, genunchiul în extensie, șoldul flectat, piciorul așezat pe un taburet;
- ✓ În această faza de recuperare, obiectivul este de a obține o flexie între 60° și 70°, maxim 75°.

Zilele 4 și 5

- ✓ Se păstrează schema de recuperare din zilele precedente, introducând exerciții efectuate din poziția așezat, fapt ce permite lucru pe amplitudini până la cele 70-75° obținute;
- ✓ Se fac exerciții în lanț kinetic închis cu încărcare parțială, pacientul poziționat la capătul mesei sau pe un scaun, solicitând activ cvadricepsul și ischiogabierii.

Zilele 6 și 7

- ✓ Exercițiile anterioare sunt păstrate, dar obiectivul acum este de a ajunge la 75-80° de flexie;
- ✓ Se introduc exerciții pentru recâștigarea autonomiei la urcare și coborârea scărilor.

Zilele 8, 9 și 10

- ✓ Obiectivul de a ajunge la 90° de flexie;
- ✓ Se încep exercițiile efectuate din ortostatism – încărcarea pe membrul inferior operat. Triplă flexie pe amplitudinea 0-30° în lanț kinetic închis.
- ✓ Lucrul pasului posterior;
- ✓ Transferul de greutate pe membrul inferior operat, acesta fiind extins din genunchi;
- ✓ Ridicare pe vârfurile picioarelor;
- ✓ Propriocepție: pacientul în așezat, picioarele pe sol, genunchiul flectat la 70°, se execută sabilizarea ritmică.

Ulterior, se introduc exerciții pentru creșterea forței musculare cu greutate sau cu rezistență din partea kinetoterapeutului; exerciții de echilibru static, dinamic, echilibru pe suprafețe instabile, echilibru unipodal; exerciții de propriocepție dinamice. Se renunță treptat la echipamentele de mers ajutătoare.

Rezultate și discuții

Analiza durerii - În cadrul evaluării durerii, realizată prin intermediul scalei VAS a fost întrebat pacientul care este nivelul durerii pe care îl resimte. Au fost alese două momente: inițial – prima zi de recuperare și final – ultima zi de recuperare.

- ❖ Pentru grupul de control - la evaluarea inițială au fost înregistrată o medie a durerii la grupul de control de 2,333, iar la finalul celor 3 săptămâni, același grup având o intensitate a durerii în medie de 0,666. Așadar, durerea percepută de grup a scăzut, în medie, cu 1,66 puncte pe scala VAS.
- ❖ Pentru grupul experimental – inițial, media intensității durerii a fost de 2,666 puncte, scâzând în final, cu 1,666 puncte, până la o medie de 0,666 puncte pe scala VAS.

Tabelul 2. Analiza intensității durerii

Lot experimental				**Lot de control**			
Pacienți	**Inițial**	**Final**	**Diferența**	**Pacienți**	**Inițial**	**Final**	**Diferența**
A.R.	4	2	3	**J.C.**	0	0	0
G.L.	4	2	2	**I.N.**	4	2	-2
T.T.M.	4	3	4	**P.N.**	4	3	-1
Media	2,333	0,666	-1,666	**P.L.**	0	0	0
Abaterea standard	2,516	1,154	1,527	**C.B.**	4	1	-3
				C.F.	4	0	-4
				Media	2,666	1	-1.666
				Abaterea standard	2,065	1,264	1,632

În faza inițială, grupul experimental a sesizat o durere mai mare decât grupul de control, respectiv 2,666 puncte față de 2,333 puncte în medie. Și la final, media durerii grupului experimental a fost mai ridicată: 1 față de 0,666 a grupului de control. Deși grupul experimental prezintă o durere superioară în final, progresul este același în cadrul ambelor grupuri, mai exact durerea a scăzut cu 1,666 puncte pe scara VAS (medie), cu o abatere standard de 1,527 pentru grupul de control și 1,632 pentru grupul experimental.

Nivelul durerii a rămas superior la grupul experiental, dar dimanica durerii a urmat un curs asemănător în cazul ambelor grupuri.

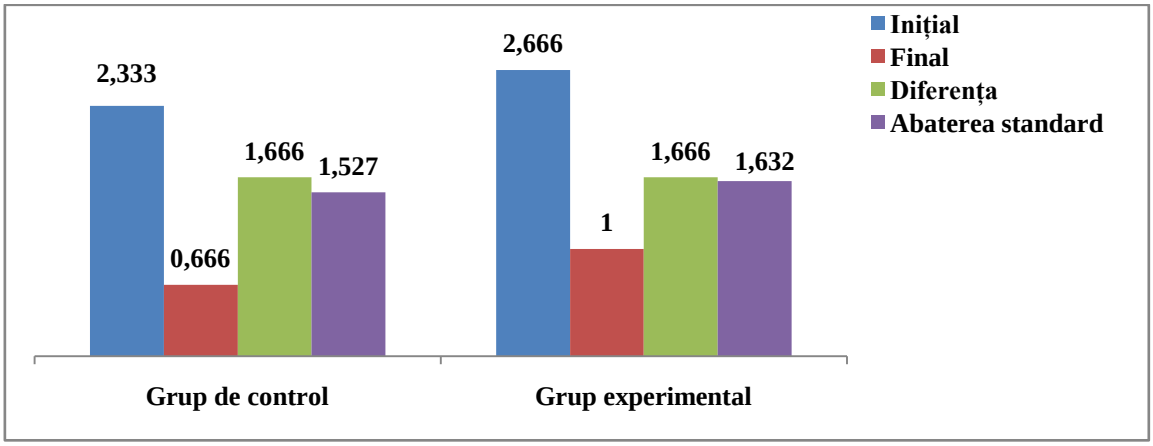

Figura 1. Variația durerii la cele două grupuri

Literatura internațională prezintă păreri împărțite legate de variația durerii în relație cu folosirea mobilizării pasive continue în tratamentul de recuperare după artroplastia totală de genunchi.

De asemenea și Maniar, R.N. și colab. [9] susțin folosirea mobilizării pasive continue în vederea reducerii durerii după protezele totale de genunchi. Studiul de față analizează variația durerii la 3 grupuri: (1) un grup de control, care a avut parte de un program convențional de kinetoterapie; (2) un grup care a avut parte de un program convențional de kinetoterapie, plus două ședințe a câte 15 minute de mobilizare pasivă continuă în ziua 2 postoperatorie; (3) un grup care pe lângă kinetoterapia convențională beneficiază de 3 zile de mobilizare pasivă continuă 2 ședințe de 15 minute pe zi. Durerea s-a ameliorat la toate grupurile din perioada imediat postoperatorie până după 3 luni. Totuși, nivelul cel mai scăzut al durerii a fost la grupul 2 (cu o zi de mobilizare pasivă continuă + kinetoterapie), dar diferența nu a fost statistic semnificativă.

Într-un studiu mai recent, 2014, Boese, C. K., Weis, M., Philips, T., și colab.[2], au avut 3 grupuri:

- Grupa A – mobilizare pasivă continuă din prima zi minimum 5 ore pe zi până când pacientul ajunge la o flexie de 90 de grade în activ;
- Grupa B – pacientul a fost poziționat într-o postură de flexie a genunchiului pe parcursul primei nopți postoperatorie. Inițial s-a dorit o flexie de 90 de grade, dar aceasta amplitudine a fost diminuată pentru comfortul pacientului;
- Grupa C – nu folosește mobilizarea pasivă continuă. Membrul inferior operat este repoziționat în pat în funcție de comfortul pacientului.

Durerea din timpul nopții a fost mai mare la pacienții cărora li s-a aplicat mobilizarea pasivă continuă, cel mai evident moment pentru a demonstra acest fapt fiind prima noapte după operație.

Autorii concluzionează că durerea pacienților care folosesc mobilizarea pasivă continuă este mai mare decât a celor care nu folosesc.

Analiza mobilității genunchiului

Pentru mișcarea de flexie a genunchiului

Grupul de control – a avut inițial o flexie activă de 62°, iar pasivă de 66,666°, crescând la finalul studiului cu 40° activ și 45,333° pasiv, astfel că la final media grupului a fost pe flexia activă de 102±7,211° și 112±2,645° pe cea pasivă.

Tabelul 3 – Analiza mobilității genunchiului - flexia (°)

Lot	Pacienți	Inițial		Final		Diferența	
		Activ	Pasiv	Activ	Pasiv	Activ	Pasiv
Control	C.J.	80	85	100	110	20	25
	D.E.	76	80	110	115	34	35
	M.B.	30	35	96	111	66	76
	Media	**62**	**66,666**	**102**	**112**	**40**	**45,333**
	Abaterea standard	**27,784**	**27,537**	**7,211**	**2,645**	**23,579**	**27,024**
Exeperimental	J.C.	80	85	110	115	30	40
	I.N.	73	90	109	116	36	26
	P.N.	28	34	93	100	65	66
	P.L.	50	55	90	108	40	53
	C.B.	60	70	112	118	52	48
	C.F.	65	73	113	120	48	47
	Media	**59,333**	**67,833**	**104,5**	**112,833**	**45,166**	**46,666**
	Abaterea standard	**18,522**	**20,624**	**10,212**	**7,494**	**12,56**	**13,321**

Grupul experimental – a avut evoluții pozitive pe mișcarea de flexie, astfel că în final toți pacienții au progresat, rezultatele fiind în medie îmbunătățite cu 45,166° pe flexia activă și 46,666° pe cea pasivă.

Progresul este vizibil în ambele grupuri (figura 2). Media amplitudinilor inițiale sunt similare: 62° activ, respectiv 66,66° pasiv la grupul de control și 59,333° active și 67,833° pasiv la grupul experimental. În flexia activă, grupul de control a obținut 102° și cel experimental 104,5°, iar în cea pasivă, grupul de control 112° și cel experimental 112,833°. Deși grupul experimental a obținut o amplitudine mai mare decât grupul de control, acest câștig este mic: 2,5° pentru flexia activă și 0,833° pentru flexia pasivă.

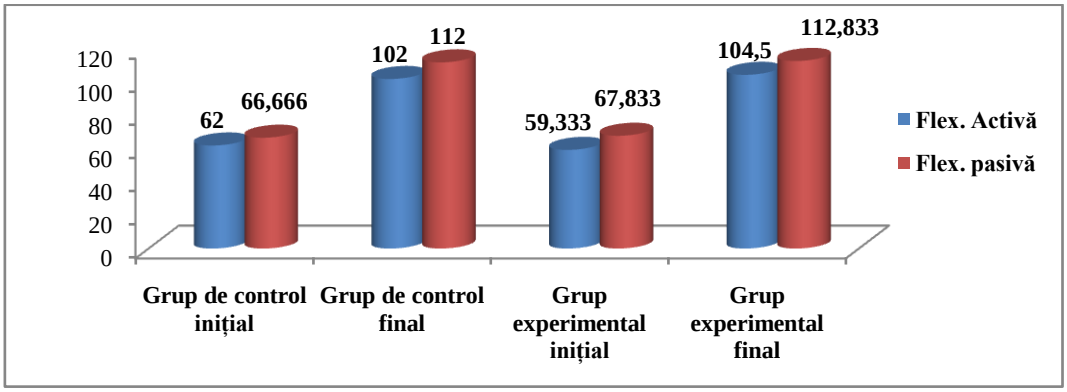

Figura 2 - Variația mobilității genunchiului – flexie

Ideea că mobilizarea pasivă continuă nu este neapărat benefică în câștigarea amplitudinii genunchiului operat este abordată și de alți cercetători.

Articolul ”*Is Continuous Passive Motion Beneficial for Early Post Operative Period in TKS Patients?*”[6] are ca și concluzie faptul că: mobilizarea pasivă continuă nu aduce beneficiu adițional programului de kinetoterapie clasic pentru pacienții cu proteză totală de genunchi, mai precis la pacienții care au o amplitudine de mișcare inițială slabă, în special flexie (45°–75°), kinetoterapia clasică este suficientă în reabilitarea postoperatorie după artroplastia totală de genunchi. Studiul a fost realizat pe un total de 150 pacienți, selectați aleatoriu, cu un grup de control de 75 de persoane și un grup experimental de 73 de persoane. Grupul de control a beneficiat doar de kinetoterapie, iar grupul experimental a beneficiat de kinetoterapie plus mobilizare pasivă continuă. Pacienții au fost evaluați de două ori: prima oară cu două săptămâni înainte de intervenția chirurgicală și a doua la 7 zile după operație. În urma studiului, rezultatele au arătat că nu există o diferență semnificativă în flexia și extensia pre- și postoperatorie. Tot de aceeași părere sunt și Moore Paula și Lake Fiona [10], în studiul cărora este analizat un lot de 87 de pacienți post artroplastie totală de genunchi, 48 pacienți au beneficiat de mobilizare pasivă continuă după operație și 39 nu au beneficiat. Cele două grupuri nu au arătat diferențe semnificative de flexie de genunchi înainte și după operație sau întârziere de începere a flexiei în urma intervenției. 88% din pacienți erau capabili să facă o flexie de 80 de grade înainte de operație, iar după 74% din pacienți și-au recăpătat această capacitate.

Madeleine Denis și colab. săi [4] au încercat să ia mai în amănunt problematica utilizării mobilizării pasive continue folosind două grupuri experimentale cu durată diferită de aplicare a mobilizării. Astfel, au avut 3 grupuri: (1) grupul de control, care primește doar ședințe de kinetoterapie; (2) grup experimental 1, care beneficiază de kinetoterapie și mobilizare pasivă continuă timp de 35 de minute în fiecare zi; (3) grup experimental 2, care are parte de un program de kinetoterapie convențional și 2 ore de mobilizare pasivă contină pe zi. În final, s-a demonstrat că nu există diferență semnificativă pentru flexia activă a genunchiului între cele 3 grupuri.

Pentru mișcarea de extensie a genunchiului

S-a plecat cu deficite de extensie, atât activ cât și pasiv, pentru majoritatea pacienților, atât din lotul de control cât și din cel experimental, cu mici excepții, care nu prezentau deficit fie pe una dintre testări (activă sau pasivă), fie pe ambele (tabelul 3).

Tabelul 4 – Analiza mobilității genunchiului - extensia (°)

Lot	**Pacienți**	**Inițial**		**Final**		**Diferența**	
		Activ	**Pasiv**	**Activ**	**Pasiv**	**Activ**	**Pasiv**
Control	**C.J.**	-5	0	-3	0	+2	0
	D.E.	-6	-3	-2	0	+4	+3
	M.B.	-10	-5	-6	-2	+4	+3
	Media	-7	-2,666	-3,666	-0,666	3,333	2
	Abaterea standard	2,645	2,516	2,081	1,154	1,154	1,732
Exeperimental	**J.C.**	-5	0	-3	0	+2	0
	I.N.	-15	-10	-8	0	+7	+10
	P.N.	-10	-6	-7	-4	+3	+2
	P.L.	0	0	0	0	0	0
	C.B.	-12	-8	-10	-5	+2	+3
	C.F.	-14	-10	-10	-6	+4	+4
	Media	-9,333	-5,666	-6,333	-2,5	3	3,166
	Abaterea standard	5,785	4,633	4,033	2,81	2,366	3,71

Grupul de control prezintă un deficit de extensie mai mic și în activ și în pasiv, atât în momentul inițial cât și în cel final. Media deficitului de extensie activă a fost inițial -7° la grupul de control, iar la grupul experimental -9,33°. Media deficitului de extensie pasivă a fost inițial -3,66° la grupul de control, iar la grupul experimental -6,33° (figura 3).

Deși diferențele de mobilitate a genunchiului înclină balanța spre grupul de control, acesta având o extensie global mai puțin deficitară, progresele obținute în urma programelor de recuperare sunt aproape identice: activ 3,33° grupul de control și 3° grupul experimental; pasiv 3° grupul de control și 3,16° grupul experimental. Așadar, mobilizarea pasivă continuă nu duce la o ameliorare mai rapidă sau mai pronunțată a deficitului de extensie post-operație de tip artroplastie totală de genunchi.

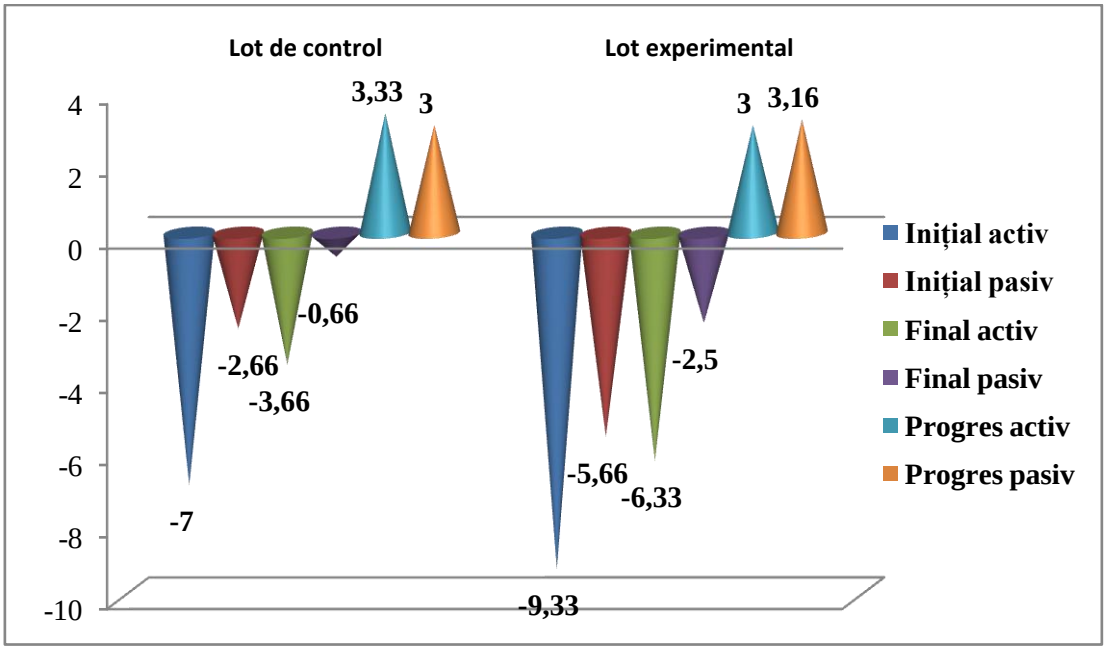

Figura 3. Variația mobilității genunchiului – extensie

Concluzii

În urma studiului realizat, am tras următoarea concluzie: mobilizarea pasivă continuă nu aduce beneficiu concret față de programul de kinetoterapie clasic pentru pacienții cu proteză totală de genunchi, motiv pentru care achiziționarea de aparatură în plus necesară recuperării genunchiului protezat, pe lângă faptul că aduce costuri suplimentare, este din punct de vedere al eficienței recuperării inutilă.

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MODIFICĂRI POSTURALE LA COPIII ȘI ADOLESCENȚII CU ANOMALII ALE PICIORULUI – O REVIZUIRE SISTEMATICĂ

POSTURAL CHANGES IN CHILDREN AND ADOLESCENTS WITH FOOT ABNORMALITIES – A SYSTEMATIC REVIEW

Andra-Bianca Bușulia[1], Mihaela Oravițan[2]

Abstract

Postural faults in children and adolescents represent one of the most popular yet underestimated health problems because of the subsequent complications they may produce. One of the causes that can contribute to the young organism's posture disorders are the alterations in the foot's structure and functionality, which are more and more frequently discovered. This study aimed to investigate the postural changes induced by foot deformities and/or dysfunctions in children and adolescents. The methodology involved a systematic search using Clarivate Analytics, PubMed, ResearchGate, and Google Scholar databases in order to obtain information regarding the postural changes associated with foot abnormalities; 188 articles were found after we applied the inclusion criteria, but finally, only 17 were relevant to our research. The analysis of these showed that: there is evidence for poor postural stability in the pronated and supinated foot, foot deformities are a risk factor for injuries of the lower extremity due induced postural changes, foot position can influence the pelvic alignment in children (especially, an increased anteversion of the pelvis on those with hyper pronated foot), can produce trunk asymmetries, and also can change the gait kinematics and create an excessive load on various joints of the spine and lower limb. In conclusion, is confirmed the idea that even a minor alteration in foot structure and/or functionality is followed by poor postural habits based on feedback and other advanced control mechanisms. These changes could lead to more complicated health issues.

Keywords: *posture, foot deformity, foot posture, children, adolescents*

Rezumat

Deficiențele posturale la copii și adolescenți reprezintă una dintre cele mai populare, dar totuși subestimate probleme de sănătate din cauza potențialelor complicații ulterioare. Una dintre cauzele care pot contribui la tulburările posturale ale organismului tânăr sunt modificările structurii și funcționalității piciorului, care sunt descoperite din ce în ce mai frecvent. Acest studiu a avut ca scop investigarea modificărilor postural induse de deformările și/sau disfuncțiile piciorului la copii și adolescenți. Metodologia a implicat o căutare sistematică utilizând bazele de date Clarivate Analytics, PubMed, ResearchGate și

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Google Scholar pentru a obține informații cu privire la modificările posturale asociate anomaliilor piciorului. Au fost găsite 188 de articole care îndeplineau criteriile de includere, dar, în final, doar 17 au fost relevante pentru cercetarea noastră. Analiza acestora a arătat că: există dovezi pentru o stabilitate posturală slabă la piciorul pronat și supinat, deformările piciorului sunt un factor de risc pentru leziunile extremității inferioare datorate modificărilor posturale induse, poziția piciorului poate influența alinierea pelviană la copii (în special, o anteversie crescută a pelvisului la cei cu picior hiperpronat), poate produce asimetrii ale trunchiului și, de asemenea, poate schimba cinematica mersului și poate crea o sarcină excesivă asupra diferitelor articulații ale coloanei vertebrale și ale membrului inferior. În concluzie, se confirmă idea că și o modificare minoră a structurii și/sau a funcționalității piciorului este urmată de modificări posturale defectuoase bazate pe feedback și pe alte mecanisme avansate de control. Aceste schimbări ar putea determina probleme de sănătate mai complicate.

Cuvinte cheie*:* *postură, deformarea piciorului, postura piciorului, copii, adolescenți*

Introduction

Posture is described as a set of interactions between the musculoskeletal system and the central nervous system and its main role is to keep the body in a state of balance by protecting its supporting structures against injuries or progressive deformities [1].

Movement and postural patterns are essential components of a child's physical and emotional development [2]. Body posture failures in children and adolescents constitute one of the most popular yet underestimated health problems. A sedentary lifestyle among children and adolescents is an important factor that intensifies incorrect body postures in daily activities [3, 4]. Nowadays, we are dealing with an increased number of children and adolescents who have musculoskeletal pain without trauma [4, 5].

The human foot plays a fundamental role by linking the body with the ground. Therefore, it is a significant contributing factor in the overall development of the musculoskeletal system in children [6]. Foot misalignment is one of the most common orthopedic issues in pediatric health and it leads to many injuries in the foot, knee, and lower back. If normal foot posture does not develop during the elementary school period, foot misalignment continues to evolve during adolescence and into adulthood. Therefore, the development of normal foot posture during childhood is essential [7].

The entire kinematic chain can be disrupted by any minor dysfunctions within the foot and consequently affects its motility. Dysfunctions of the locomotor system, though, may cause lower limb failure, translating into degenerative changes in the peripheral and spinal joints [8]. From a biomechanical point of view, foot posture can influence postural stability, bodyweight distribution, change the normal kinematics of gait, it can alter the position of the pelvis, and increase the risk of injuries.

Objective. The aim of this study is to investigate the effect of foot deformity, dysfunction, or both on postural alignment.

Materials and Methods

A computerized database search was performed to identify relevant articles for this review. The following databases were searched Clarivate Analytics, Pubmed, ResearchGate, and Google

Scholar. Selection criteria were based on the publication date (between 1990-2020), their accessibility (free full text), and using the following keywords: *posture, foot deformity, foot posture, children, and adolescents.* The studies involving adult subjects and the articles that do not have their main topic foot deformity in associations with posture were excluded.

A total of 188 studies were found in selected databases. After analyzing their content, a total of 17 articles were eligible to be included in this review.

Results

The results obtained were divided according to the effect described by certain pathology of the foot on the posture or posture-related conditions in children and/or adolescents.

- Postural stability

Four studies investigated how foot abnormalities correlate with postural stability. Cote et.al (2005) included children and adolescents with foot structural classification (supinated, pronated, and neutral) and they measured center of balance, stability index, and postural sway during static single-limb stance under eyes-open and eyes-closed conditions. They found that postural stability is affected by foot type under both static and dynamic conditions [9].

Szczepanowska-Wolowiec et al. examined (in 2019) 200 children by measuring the center of pressure (COP), using a dynamometric platform and they found a correlation between morphological variables of the foot and postural stability [8].

The effects of flexible pes planus on postural stability examined by El-Shamy and Ghait determined that there was a decrease in postural stability in adolescent females with flexible pes planus compared with normal subjects [10].

In another study, the authors measured ground force reaction (GFR) in children with flat feet. They found that flexible flat feet were associated with a reduction in the second peak of the vertical GRF, a reduction in peak ankle inversion, external rotation moments, and an increase in peak ankle eversion moment impulse. These findings add support to the belief that flexible flat feet lead to instability and abnormal foot and ankle loading [11].

- Pelvic position

Two studies identified a correlation between foot posture and pelvic alignment. One study found significant relationships between the position of heel valgus, hip rotation, and pelvic tilt. A higher anterior tilt of the pelvis was found in children during the whole gait cycle [6].

The second study involved 651 children whose footprints and internal, external rotation of both hips were measured. All of 151 children with flat feet had presented an increased internal rotation of hip; a highly significant correlation was found between flat feet and increased hip internal rotation in children [12].

- Trunk parameters

One study investigated the relationship between selected parameters of feet and trunk in children aged 4 to 6 years. Parameters of feet were significantly correlated with the angle of the body bent to the left in the frontal plane (63.01%), the height of lumbar lordosis (52.15%), the inclination of upper thoracic region (41.29%), and length of lumbar lordosis (39.11%). Foot

parameters were reported to correlate significantly with the length of thoracic kyphosis (13.04%), the inclination of the lumbosacral region (10.86%), and asymmetry in the distance between lower angles of the scapula from spinous process, with the lower angle of the left scapula being more distant. The authors revealed a significant relationship between foot parameters and trunk parameters especially in the sagittal plane than in the frontal (very low in the transverse plane); also, the authors established that left foot parameters are better correlated with trunk parameters than the ones in the right foot [13].

A positive correlation was found in one study between abnormal foot pronation and the development of scoliotic curves. The study suggests that asymmetrical pronation patterns may be a critical factor in the development of scoliotic curves.
The authors described that if a foot pronates more than the other the pelvis will rotate counterclockwise and tilt downwards towards the foot that pronates more [14].

- Kinematic gait parameters

Children with heel misalignment were examined and pressure distribution on the foot during gait was analyzed on a force platform. The results show the heel's valgus positioning influences foot loading in children during gait and the presence of pathological changes[15].

Another study investigated the relationship between foot arch and dynamic plantar pressure in preschool children. They measured 27 children for static foot posture, including navicular height and plantar pressure force, and contact areas using a 3D foot scan. They concluded that the foot arch is a factor which will influence the pressure distribution under the foot. Therefore, children with flatfeet may shift their body weight to a more medial foot position when walking and could be at a higher risk of soft tissue injury in this area [16].

GRF and support moment in normal and flat-feet children were investigated by Pauk and Griškevičius. They investigated GRF and were quantified by three vectors, in the vertical, anterior-posterior, and medial-lateral planes. They suggest that children with flat-feet tend to walk with a reduced compliance in the loading response phase due to the impaired function of the hindfoot. The amplitude of the force in posterior direction was significantly lower in flat feet children compared with normal subjects. They also study the support moment of all the joints of the lower limbs and concluded that the support moment was lower in the flat-feet group (the hip joint 21.3% for control group vs. 15.6% for flat feet subjects; the knee joint 20.3% for control group vs. 17.7% in flat feet subjects) [17].

- Whole-body flexibility

The relationship between foot posture and body flexibility in healthy asymptomatic children aged 7 to 15 years was assessed by Hawke and colleagues. They found that children with increased pronation of the foot type exhibited greater lower limb and whole-body flexibility but not greater ankle joint flexibility [18].

- Lower extremity injuries

Five studies identified foot posture as a risk factor for the development of injuries in the lower extremity. Two studies evaluated athletes with either pronated or supinated foot and reported a higher incidence in knee pain and risk of overuse injuries [19, 20].

A 125 high school cross-country runners were measured for tibiofibular varum, resting calcaneal position during gait stance, and gastrocnemius length. They supported the hypothesis that a pronated foot type is related to medial tibial stress syndrome (MTSS) with an accuracy of 76% [21].

Two studies investigated symptomatic flat feet and proximal joint problems. Both pieces of research reported that flatter foot posture is more likely to have pain or discomfort at the hip, knee or back. These results suggest that foot motion in the transverse plane is closely associated with the presence of symptoms in flat feet and is accompanied by changes in the ankle, knee, and hip kinematics [22, 23].

Discussions

This review reports data on the relationship between foot posture and association with the whole body or conditions related to a bad posture among children and adolescents.

Findings showed that foot type could be a risk factor for developing pathological changes in the kinematic chain. The results confirm the findings of previous reviews as we found that. B. Neal and colleagues investigated foot posture and function as a risk factor for lower limb overuse injuries. Studies were classified based on foot assessment method using foot posture index (FPI), navicular drop, and the longitudinal arch angle. They found a strong correlation between pronated foot posture and medial tibial stress syndrome and minimal evidence that a pronated foot posture was a risk factor for patellofemoral pain development. They investigated foot posture as a risk factor for the development of foot/ankle injury and bone stress reaction but they did not find any association between them [24].

Another study found that body posture influences load distribution in the lower limbs. They examined body posture among 78 children using the photogrammetric method and for plantar pressure they used a baropodometric pressure platform. In this study, the results showed a significant relationship between body posture failures in children such as the increased angle of thoracic kyphosis and the angle of lumbar lordosis and the load transferred by the forefoot/hindfoot. A greater angle of inclination in the thoracolumbar segment correlated with greater load transferred by the forefoot as a consequence of the forward shift of the center of gravity. Postural defects in children can influence the load distribution of both feet and the position of the center of gravity which suggests that not only foot posture can create asymmetries and compensation mechanisms inthe kinematic chain but also any alteration in body posture can influence the whole alignment [25].

Zaharieva investigated foot posture (flat feet, prone feet) in relation to posture and their association in children. A strong correlation was found between pronation and postural deviations, pronation being the leading factor for the variation in the children's posture [26]. Outcome measures are important when evaluating the effectiveness of treatment and progress towards a final goal in pediatric populations. There are a lot of conditions seen in pediatric orthopedic clinics and it is not clear how and when children develop normal foot posture and function and also when a deformity is defined as pathological.

The reliability of clinical foot measures commonly used in pediatric foot assessments has been previously investigated in various ways and for different purposes.

In one study the examiners found largely good intra-rater and inter-rater reliability for the FPI-6, Lunge test, the Beighton scale, and the lower limb assessment score (LLAS). Navicular

height (NH), the Foot Posture Index (FPI), resting calcaneal stance position (RCSP), neutral calcaneal stance position (NCSP), navicular drop (ND) were examined in young children(4 to 6 years) and adolescents (8 to 15 years) in an intra-rater and inter-rater reliability study [27].

It is known that foot posture and ankle range may influence the entire postural alignment and it is pertinent to identify the most useful measures for the clinical evaluation of these parameters. These findings indicate that the presented measures are useful in assessing the deformities of the foot that may lead to postural abnormalities [28].

The Foot Posture Index (FPI-6)was assigned to a predetermined category: highly pronated (FPI-6 score 10 to 12), pronated (FPI-6score 6 to 9), neutral (FPI-6 score 0 to 5), supinated (FPI-6 score -1 to -4) and highly supinated (FPI-6 score -5 to -12). The inter-rater reliability when the actual score was compared and when the score was categorized showed almost perfect agreement. The findings of this study show the FPI-6 has almost perfect inter-rater reliability and suggests that the FPI-6 may be of value in clinical practice [28].

Conclusion

This review identified evidence on the effects of foot posture on the entire postural alignment. We found a strong correlation between foot types and lower limb injuries and postural stability in children and adolescents. However, in the studies evaluated we found that foot posture can alter kinematic gait parameters and create an excessive load on the various joints. Any abnormality in foot posture or its functionality will create methods of compensation in the kinetic chain by postural adjustments based on feedback and advanced control mechanisms. Evaluation of static foot posture and dynamic foot functionality should be included in a multifactorial assessment in children and adolescents with foot deformities.

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STUDIU COMPARATIV PRIVIND DUREREA LA COPIII CU SCOLIOZĂ DUPĂ APLICAREA TRATAMENTULUI KINETIC

COMPARATIVE STUDY ON PAIN IN CHILDREN WITH SCOLIOSIS AFTER THE APPLICATION OF KINETIC TREATMENT

Magdalena Bughirică[1]

Abstract

Introduction: At the level of the school population in Romania, current studies have shown an increased incidence of spinal deformities. Scoliosis is one of the controversial pathologies of the spine in that although the changes on the spine are impressive, the pain being an unpleasant sensory and emotional experience is among the last symptoms felt by the patient.
The aim of the study is to evaluate, according to the visual analog scale, the incidence of back pain in children diagnosed with scoliosis.
Methods: Pain assessment was performed using a visual analog scale with 5 levels of pain, applied at the beginning and end of kinetic treatment.
Results: The results of the study on pain in children with scoliosis after the application of kinetic treatment show significant improvements. There was also an increase in joint mobility in the spine and a decrease in fatigue.
Conclusions: The pain registered a downward evolution. Predominant were the cases with a pain level of "it hurts a little more", at the beginning of the recovery, and at the end the cases with "absence of pain" predominated. The age and level of development of the child must be taken into account when approaching the assessment and kinetic treatment. Pain assessment methods must be simple, safe and easy for subjects to understand.

Keywords: *pain, visual scale, kinetic treatment*

Rezumat

Introducere. La nivelul populației școlare din România studiile actuale au arătat o incidență crescută a deformărilor coloanei vertebrale. Scolioza este una dintre patologiile coloanei vertebrale controversate prin faptul că, deși modificările asupra coloanei vertebrale sunt impresionante, durerea fiind o experienţă senzorială şi emoţională dezagreabilă este printre ultimele simptome resimtițe de către pacient.
Obiectivul studiului este de a evalua, conform scalei analong vizuale, incidenţa durerilor de spate la copiii diagnosticați cu scolioză.
Metodă. Evaluarea durerii s-a realizat prin utilizarea scalei analong vizuale cu 5 niveluri de durere, aplicându-se la începutul și sfârșitul tratamentului kinetic.

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Rezultate. Rezultatele studiului asupra durerii la copiii cu scolioză după aplicarea tratamentului kinetic evidențiază îmbunătățiri semnificative. De asemenea s-a observat o creștere a mobilității articulare la nivelul coloanei vertebrale și scăderea stării de oboseală.
Concluzii. Durerea a înregistrat o evoluție descendentă. Predominante au fost cazurile cu durere *„doare puțin mai mult”*, la începutul recuperării, iar la final au predominat cazurile cu *„absența durerii”*. În abordarea evaluării și a tratamentul kinetic trebuie să se țină cont de vârsta și nivelul de dezvoltare al copilului. Metodele de evaluare a durerii trebuie să fie simple, sigure și ușor de înțeles de către subiecți.

Cuvinte cheie: *durere, scală vizuală, tratament kinetic*

Introduction

According to specialized studies, every year more and more children and adolescents are diagnosed with scoliosis [1]. Despite the high prevalence of this pathology, there is a significant gap in the literature, with limited evidence reporting the effect of exercise on back pain in patients with scoliosis [2].

Scoliosis is a permanent deviation of the spine in the frontal plane with progressive evolution and important consequences on the morphology and functionality of the spine. The scoliotic attitude is only a problem of vertebral statics, reversible and without definitive changes of the spine. The carriers of this condition must consult a series of specialists, from different medical branches: orthopedist, rheumatologist, neurosurgeon, recovery doctor, physiotherapist, and psychologist.

Scoliosis is one of the controversial pathologies in that although changes in the spine are important (having profound implications such as: respiratory and cardiovascular disorders, changing patient quality of life, low self-esteem) pain is among the last symptoms experienced by the patient [3].

Specialist studies have shown that pain in patients diagnosed with scoliosis occurs especially in those with lumbar and thoraco-lumbar curves, and pain intensity is significant in the case of curves exceeding 45 degrees Cobb [4]. Chronic back pain has an important impact on the quality of life of patients with scoliosis. Teles et al. pointed out in their study that there is a high prevalence of pain in the study group [5]. However, persistent back pain associated with progressive scoliosis should always be taken seriously in children [6]. The association between the severity of the deformity and the somatosensory dysfunction may suggest that spinal deformity may be a trigger for pain. Pain-related factors include: changes in balance, instability, and pathological mechanical loads on the elements of the spine [7, 8].

The visible signs in scoliosis are the asymmetry of the posture of the body, stated by: the asymmetry of the shoulders, the inequality of the scapula prominence, the asymmetrical waist line, the ribs are higher on one side at the flexion of the trunk (Adam test) etc. As the scoliotic curvature progresses and puts pressure on the nerves and paravertebral muscles, it causes decreased joint mobility, back pain, weakness, numbness or pain in the lower extremities. Sometimes it can be difficult to manage pain, it can be present when lifting, walking or joint mobilization, being associated with the severity of the deformity [9].

According to the International Association for the Study of Pain (IASP), pain is an unpleasant sensory and emotional experience associated with an actual or potential tissue injury or

described in terms that suggest tissue injury (International Association for the Study of Pain, 1994). Chronic being caused by trauma, surgery or a chronic illness. „Acute pain can be considered a symptom or injury, chronic and recurrent pain is a specific health problem, a disease in itself" (The European Pain Federation (EFIC) Statement) [10] Chronic pain is defined as being any type of persistent pain for more than twelve weeks (three months). Although the causes of acute pain are usually clear, the etiology of chronic pain is extremely diverse, which can be induced by a wide variety of clinical situations. [11]

Weiss, HR., States that several clinical studies have shown that in early adulthood, most patients with scoliosis suffer from pain. Among patients with scoliosis who reported pain, they described it as "horrible, excruciating, and painful" [12]. Adolescents and adults with chronic back pain require physical treatment as well as psychological support. These patients have to deal with two different problems at the same time, spinal deformity and pain, which require more complex approaches than for the rehabilitation of pain alone.

The behavior of the child who presents with pain during the assessment or kinetic treatment may include: reduced motor activity, facial expressions, grimaces, specific positions, irritability. Older children can locate pain in the back with a body sketch. Pain information, obtained from children using assessment scales, is important in establishing a recovery therapeutic plan.

The correct assessment of pain is made according to the age and level of development of the patient. Pain assessment in older children and adolescents is performed by direct involvement of the patient, namely, by using methods of self-report (self-assessment) of pain. The numerical evaluation scale is the most used pain evaluation scale for children aged 10-15. The numbers used on this scale are placed in ascending order, thus indicating a gradual increase in pain intensity. To use this type of scale, the child must understand the concept of numbers and their proportionality. This numerical assessment scale has the advantage of not requiring complicated materials and being understood by children.

Informing the physiotherapist in case of pain during treatment increases the patient's confidence in the therapist and physical treatments.

The aim of the study is to evaluate the incidence of back pain that occurs after the application of kinetic treatment in children diagnosed with scoliosis according to the visual analog scale.

Depending on the intensity of the pain, the appropriate therapeutic action is planned. Subsequently, the pain is reassessed to assess the therapeutic efficacy.

Objectives of pain assessment:

1. Identifying the presence and intensity of pain;
2. Assessing the impact of pain on the individual;
3. Establishing the kinetic treatment.

Method and subjects

Pain assessment was performed using the visual analog scale with 5 levels of pain, applied at the beginning and end of kinetic treatment. The children self-assessed their pain on a scale from 0 to 5, where: 0 = absence of pain; 1 = hurts a little; 2 = hurts a little more; 3 = hurts more; 4 = it hurts a lot; 5 = it hurts unbearably. Physiotherapy program aimed to correct the curves of the spine by toning the muscles of the posterior plane, reducing rib hump, straightening the pelvis and balancing the scapular girdle, awareness of vicious postures of the spine by adopting corrective postures [13].

Therapeutic intervention was performed for 45 minutes twice a week for a period of 6 months. Prior to treatment, children were given individual sheets to describe pain and were instructed on the pain assessment scale and recovery program through both verbal and practical description.

The evaluation of the subjects focused on the following parameters: pain in orthostatism, gait and joint mobilization. The study was performed on a group of 20 children diagnosed with scoliosis from the Special Gymnasium School No.3. Bucharest.

Results and discussions

The group of subjects with scoliosis was analyzed in terms of distribution by age groups and sex. The research involved 20 children aged 10-15 years (average is 13 years).

* Gender structure. It confirms the data from the literature that shows the predominance of females. The analysis of the cases studied shows a preponderance of the disease in females (70% girls out of the total number of students studied, i.e. 14 cases of girls and 30% boys, ie 6 boys).

* The topography of scoliosis presented:

- 9 cases with a single thoracic curvature with right convexity.
- 3 cases with a single thoracic curvature with convexity on the left.
- 5 cases with a single thoracolumbar curvature with right convexity.
- 3 cases with 2 curves of right chest and left lumbar

* Data analysis was performed using the Excel program. The intensity of pain before and after the kinetic treatment is presented in the tables below in tables 1, 2 and 3.

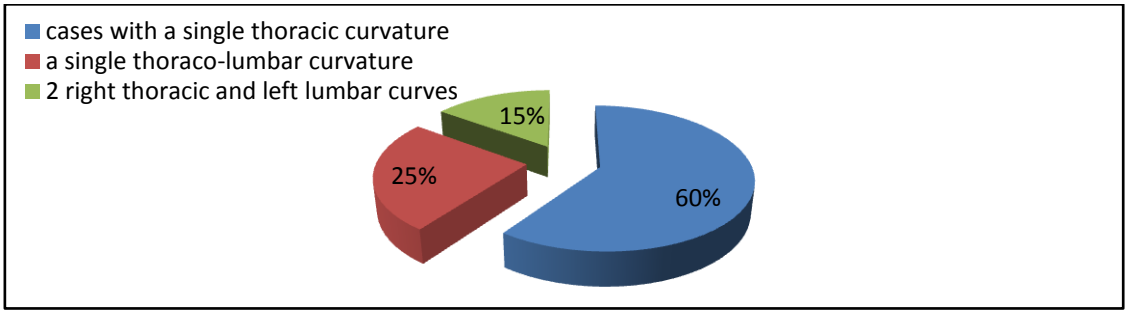

Fig.1 Distribution of scoliosis according to topography

Table 1. Analysis of pain in orthostatism in the cases studied before and after treatment.

At the beginning of the recovery:	**At the end of the recovery:**
4 cases - absence of pain	14 cases - absence of pain
3 cases - it hurts a little	3 cases - it hurts a little
6 cases - it hurts a little more	2 cases - it hurts a little more
5 cases - more pain	1 case - more pain
2 cases - it hurts a lot	
0 cases - it hurts unbearably	

Table 2. Analysis of pain while walking before and after treatment.

At the beginning of the recovery:	**At the end of the recovery:**
5 cases - absence of pain	11 cases - absence of pain
6 cases - it hurts a little	7 cases - it hurts a little
8 cases - it hurts a little more	2 cases - it hurts a little more
0 cases - it hurts more	
1 case- it hurts a lot	
0 cases-it hurts unbearably	

Table 3. Analysis of pain at joint mobilization before and after treatment.

At the beginning of the recovery:	**At the end of the recovery:**
3 cases - absence of pain	9 cases - absence of pain
2 cases - it hurts a little	6 cases - it hurts a little
4 cases - it hurts a little more	3 cases - it hurts a little more
7cases - it hurts more	2it hurts more
13case- it hurts a lot	
1 cases-it hurts unbearably	

The pain was downward. Predominant were the cases with pain, it hurts a little more, at the beginning of the recovery, and at the end the cases "absence of pain" predominated.

The analysis of pain in orthostatism showed a predominance of pain, it hurts a little more, and after the kinetic treatment, the absence of pain is 70% in the studied cases.

Analysis showed pain on walking pain predominant „just slightly more", and after the kinetic treatment „absence of pain" is 55% of the cases studied.

The analysis of the pain at the joint mobilization showed a predominance of the pain „ it hurts more „ and after the kinetic treatment „the absence of the pain„ is in proportion of 45% in the studied cases.

The intense pain was present in one subject during the joint mobilization after completing kinetic treatment has reached the 3 scale evaluation. The study of the correlation between the sexes showed significant differences. Also there was an increase joint mobility in the spine and decrease fatigue in subjects.

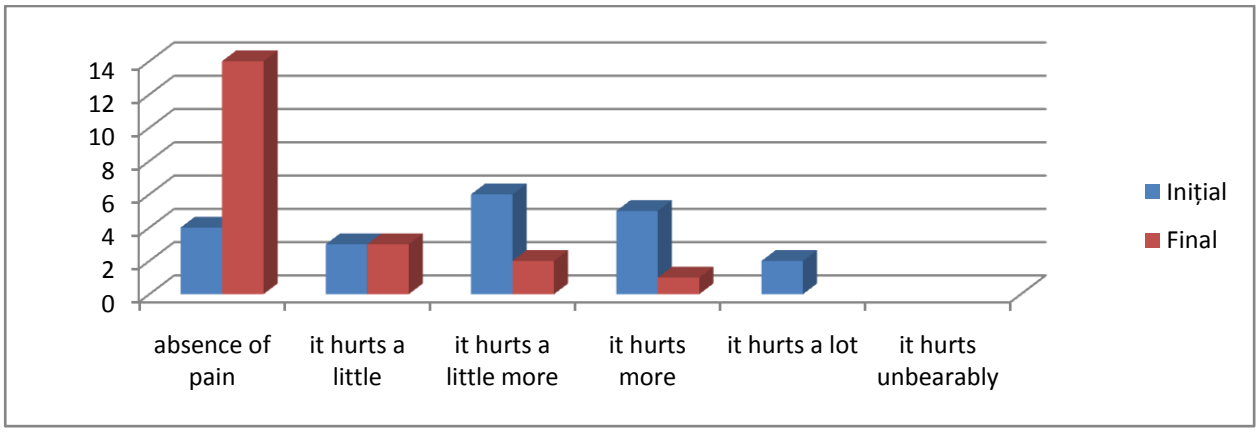

Figure 2. Graphical representation of pain in orthostatism -a) initial test b) final test

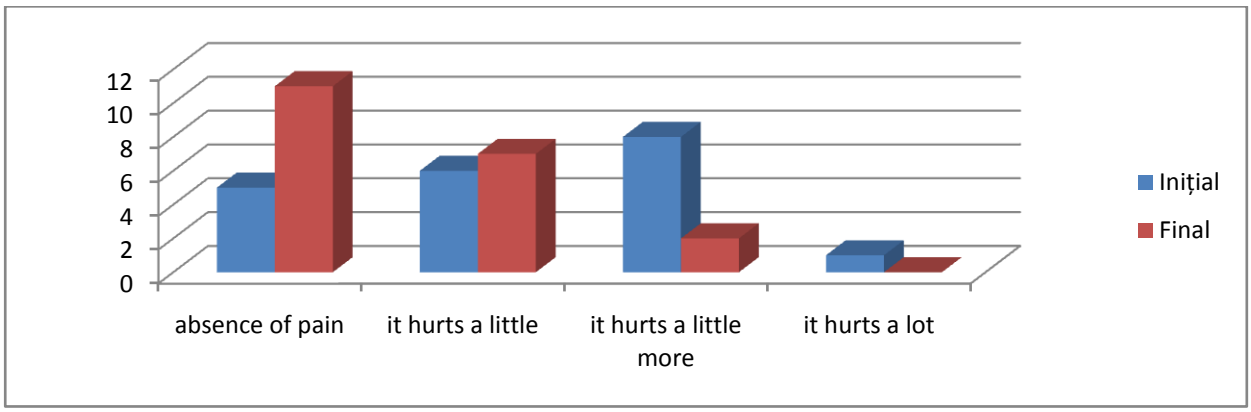

Figure 3. Graphical representation of pain on walking -a) initial test b) final test

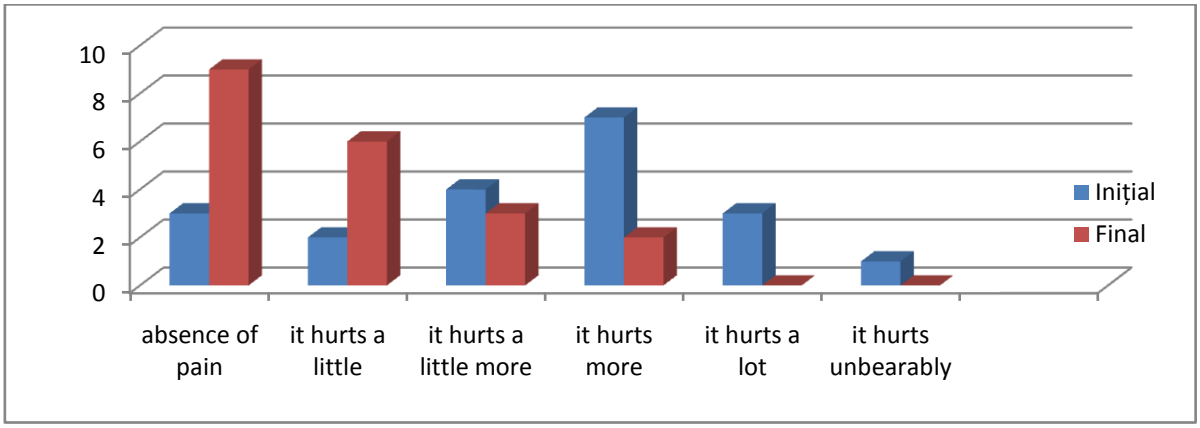

Figure 4. Graphical representation of pain at joint mobilization -a) initial test b) final test.

Conclusions

There is a higher incidence of scoliosis cases in females, in a percentage of 70%, this being confirmed by the literature.

The pain was downward. Predominant were the cases with pain "it hurts a little more", at the beginning of recovery, and at the end the cases "absence of pain" predominated.

Pain assessment methods must be simple, safe and easy for children to understand, taking into account the child's age and level of development.

The success of recovering children with scoliosis depends on the positive relationship that is established between the physiotherapist and the child/his family. Any change in the patient's condition must be monitored and can be remedied as soon as possible by a specialist.

Depending on the age and level of understanding, the child must become involved in his own improvement in health.

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EFECTUL ACTIVITĂŢILOR FIZICE PRACTICATE ÎN SĂLI DE FITNESS ASUPRA FORŢEI ŞI REZISTENŢEI MUŞCHILOR "CORE" LA FEMEI ADULTE

EFFECTS OF PHYSICAL ACTIVITY PRACTICED IN GYMS ON ADULT WOMEN'S CORE MUSCLE STRENGTH AND STABILITY

Klara Kalman[1], Iacob Hanţiu[2], Doriana Ciobanu[2]

Abstract

Aim: The aim of our study was to evaluate the strength and resistance of the muscles of the abdomino-lumbo-pelvic area in women and to evaluate the effect of physical activities performed in gyms on the strength and stability of the core muscles. *Hypotheses:* 1. The combined physical activity program (Pilates, step-aerobics and strength training) practiced in gyms, may increase the strength and stability of the core muscles. 2. The effects of the intervention program on the strength and stability of the core muscles are manifested differently depending on the age range. *Subjects and methods:* This study involved 95 adult women, who practiced physical activities in two gyms in Oradea, for 12 months, between February 2015 and June 2016. To test the strength and stability of the core muscles we used the functional test "Core Muscle Strength and Stability Test". The physical activity program consisted in combined training of Pilates, Step - aerobics and strength training in the gym, 3 times a week for 60-90 minutes, for 12 months. *Results:* Results of the core muscle strength and stability test: at the initial assessment, 69 subjects (72.7%) were able to complete only the first stage of the test, 1 subject (1.1%)completed stage 2, 3 subjects (3.1%), stage 3, 4 subjects (4.2%) reached stage 4, 13 (13.6%), up to stage 5, and 5 subjects (5.3%) managed to complete the test. At the final evaluation, 20 subjects (21.1%) completed the first stage, 26 subjects (27.5%), the 3rd stage, 18 subjects (18.9%), the 5th stage, 3 subjects (3.1%), stage 6, 10 subjects (10.5%), stage 7, and 18 subjects reached stage 8 and completed the test. *Conclusions:* At the core muscle strength and stability test, almost all subjects improved their results: the number of subjects who received the excellent grade increased from 5 (5.3%) at the initial evaluation, to 31 (32.5%) at the final evaluation. So we can conclude that our hypothesis has been confirmed, the combined physical activity program (Pilates, step-aerobics and strength training) having a beneficial effect on the strength and stability of the core muscles.

Keywords: *core muscles, core muscle strength and stability, adult women, physical activity*

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Rezumat

Scop: Scopul studiului nostru a fost evaluarea forţei şi rezistenţei muşchilor zonei abdomino-lombo-pelviene la femei şi evaluarea efectului activităților fizice practicate în săli de fitness asupra forţei şi rezistenţei muşchilor "core". *Ipoteze:* 1. Programul de activitate fizică combinat (Pilates, step-aerobic şi antrenament de forţă) practicat în săli de fitness, poate să crească forţa şi rezistenţa muşchilor zonei abdomino-lombo-pelviene (core muscles). 2. Efectele programului de intervenţie asupra forţei şi rezistenţei muşchilor zonei abdomino-lombo-pelviene (core muscles) se manifestă diferit în funcţie de intervalul de vârstă. *Subiecţi şi metode:* La acest studiu au participat 95 de femei adulte, care au practicat activităţi fizice în două săli din Oradea, timp de 12 luni, în perioada februarie 2015 – iunie 2016. Pentru testarea forţei şi rezistenţei muşchilor nucleului (core) am utilizat testul funcţional „Testul de stabilitate şi forţă musculară core". Programul de exerciţii a constat din antrenamente combinate între Pilates, Step – aerobic şi antrenament în sala de fitness, de 3 ori pe săptămână câte 60-90 de minute, timp de 12 luni. *Rezultate:* Rezultatele testului de stabilitate şi forţă musculară „core": la evaluarea iniţială, 69 subiecţi (72,7%) au putut completa numai prima etapă a testului, 1 subiect (1,1%), etapa a 2-a, 3 subiecţi (3,1%), etapa a 3-a, 4 subiecţi (4,2%) au ajuns la etapa a 4-a, 13 (13,6%), până la etapa a 5-a, iar 5 subiecţi (5,3%) au reuşit să finalizeze testul. La evaluarea finală, 20 subiecţi (21,1%) au completat prima etapă, 26 subiecţi (27,5%), etapa a 3-a, 18 subiecţi (18,9%), etapa a 5-a, 3 subiecţi (3,1%), etapa a 6-a, 10 subiecţi (10,5%), etapa a 7-a, iar 18 subiecţi au ajuns la etapa a 8-a şi au completat testul. *Concluzii:* La testul de stabilitate şi forţă musculară core aproape toţi subiecţi şi-au îmbunătăţit rezultatele: numărul subiecţilor care au primit calificativul excelent crescând de la 5 (5,3%) la evaluarea iniţială, la 31 (32,5%) la evaluarea finală. Deci putem concluziona că s-a confirmat ipoteza noastră, programul de activitate fizică combinat (Pilates, step-aerobic şi antrenament de forţă) având efect benefic asupra forţei şi rezistenţei muşchilor "core".

Cuvinte cheie: *muşchii core, forţa şi rezistenţa muşchilor core, femei adulte, activitate fizică*

Introduction

Core stability training has grown in popularity over 25 years, initially for back pain prevention or therapy. Subsequently, it developed as a mode of exercise training for health, fitness and sport. The scientific basis for traditional core stability exercise has recently been questioned and challenged, especially in relation to dynamic athletic performance.

Core strengthening has become a major trend in rehabilitation. The term has been used to connote lumbar stabilization, motor control training, and other regimens. Core strengthening is, in essence, a description of the muscular control required around the lumbar spine to maintain functional stability. Despite its widespread use, core strengthening has had meager research. [1]

Stability or increased strength of the abdomino-lumbo-pelvic region has become, since the late 1990s, a well-known trend in fitness, which has penetrated both in sports medicine and physical therapy. [2, 3, 4, 5]

The"core" has been described by Richardson et al. in 1999 as a box with the abdominals in the front, paraspinals and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom.

The "core" muscles can be generally defined as 29 pairs of muscles that support the abdomino-lumbo-pelvic complex and help stabilize the spine, pelvis and muscle chains that ensure functional movements [6]. Stabilization is given by the deep muscles, which are closer to the joint: the transversus abdominis and multifidus, in particular, but also the internal oblique, rotators, semispinal, psoas major and minor. The superficial muscles are usually larger and make the transfer and balance of external loads and perform ample movements: rectus abdominis, external oblique, spinal erectors (iliocostal, spinal, longisimus), latissimus dorsi, gluteus maximus and medius, hamstrings, rectus femoris and quadratus lumborum.

For women, this is a very important area, especially after pregnancy, but also before and during pregnancy as it is very important to tone the abdomino-lumbo-pelvic area. All women want a sucked abdomen, but most of them work only the rectus abdominis, possibly obliques and have not even heard of "core muscles".

Aim: The aim of our study was to evaluate the strength and resistance of the muscles of the abdomino-lumbo-pelvic area (core muscles) in women and to evaluate the effect of physical activities performed in gyms on the strength and stability of the core muscles.

Hypotheses:

1. The combined physical activity program (Pilates, step-aerobics and strength training) practiced in gyms, may increase the strength and stability of the core muscles.

2. The effects of the intervention program on the strength and stability of the core muscles are manifested differently depending on the age range.

Materials and methods

Subjects

This study involved 95 adult women, who practiced physical activities in two gyms in Oradea, for 12 months. The research included only those women who showed interest, accepted the measurements and agreed that their data be used in research.

Methods

To test the strength and endurance of the core muscles, we used the functional test "The Core Muscle Strength and Stability Test" after Mackenzie [7, 8].

Tong, Wu & Nie in 2014 evaluated the validity and reliability of the test in assessing the overall function of the core muscles. They suggest that the core muscle strength and stability test is a valid, reliable one and it is a practical method for assessing global core muscle endurance in athletes, especially if a trial to familiarize with the test takes place before the measurement.

The aim of the test is to monitor the development of the abdominal and lumbar muscles of the subjects. To perform the test we needed a flat, non-slip surface, a mat, a stopwatch. The test includes 8 stages, in each stage the subject must maintain certain positions for a predetermined time.

Description of the test:

Stage 1:

- a short warm-up is performed;
- the subject assumes the starting position using the mat to support their elbows and arms;
- once the subject reached the right position, the test administrator starts the timer;
- the subject holds this position for 60 seconds. (Figure no.1)

Figure no. 1. Stage 1 of the Core Muscle Strength and Stability Test

Stage 2:

- the subject lifts their left arm off the ground and extends it out in front of them parallelly with the ground (Figure no.2);
- the subjects holds the position for 15 seconds.

Figure no. 2. 2nd stage of the Core Muscle Strength and Stability Test

Stage 3:

- the subject returns to the starting position, raises the right arm from the ground, extends it parallelly to the ground (same as Figure no. 2, raises the other arm);
- the subjects holds the position for 15 seconds.

Stage 4:

- the subject returns to the starting position, lifts the left leg off the ground, extends the knee, parallelly with the ground (Figure no.3);
- the subjects holds the position for 15 seconds.

Figure no. 3. Stage 4of the Core Muscle Strength and Satbility Test

Stage 5:

- the subject returns to the starting position, lifts the right leg off the ground, extends the knee, parallelly with the ground (same as Figure no.3, raises the other leg);
- the subjects holds the position for 15 seconds.
-

Stage 6:

- the subject returns to the starting position, lifts the left leg and right arm off the ground, extends them to be parallelly with the ground (Figure no. 4);
- the subjects holds the position for 15 seconds.

Figure no. 4. Stage 6of the Core Muscle Strength and Stability Test

Stage 7:

- the subject returns to the starting position, lifts the right leg and left arm off the ground, extends them to be parallelly with the ground (same as Figure no.4, with the opposite arm and leg);
- the subjects holds the position for 15 seconds.

Stage 8:

- the subject returns to the starting position (Figure no. 1);
- the subjects holds the position for 30 seconds.

Application of the test: before the start of the test, all positions must be demonstrated to the subjects, and the test administrator must ensure that each subject adopts the position specific to the corresponding stage. Throughout the test, the head, neck, back and pelvis should be kept in the correct plank position (Figure 1). If the subject is unable to maintain this position then the test must be stopped.

The stage at which the subject is no longer able to maintain the correct body position or can no longer continue the test, is recorded.

If the subject is able to complete the test it means that she/he has good endurance and strength of the core muscles. If the resistance of the core muscles is weaker, the subject cannot complete the test and will move his torso unnecessarily during the test, which causes energy loss. The interpretation of the test is made in accordance with the score awarded according to Table no.1. Scoring is based on the phase completed with the correct postural alignment. The score will be recorded and will represent the stage that the subject completed before falling to the floor or having an inappropriate posture.

Table1. The Core muscle strength and stability test scoring

Stage	**Time**	**Grade/Qualifying**
Stage 1	60 sec	Needs improvement
Stage 2	75 sec	Needs improvement
Stage 3	90 sec	Needs improvement
Stage 4	105 sec	Good
Stage 5	120 sec	Good
Stage 6	135 sec	Excellent
Stage 7	150 sec	Excellent
Stage 8	180 sec	Excellent

The data obtained were statistically analyzed with the IBM SPSS program, version 23 (descriptive analysis, frequency).

Applied physical activity program

Following the new recommendations of the American College of Sports Medicine - ACSM (2018) [9] on performing physical activities in adults aged 18-64, in addition to aerobic physical activities of moderate intensity (150 minutes/week) or vigorous (75 minutes/week) and muscle

toning (2 times/week), there were recommended endurance exercises 2-3 times/week, exercises to increase flexibility 2 times/week, and the practice of neuromotor exercises, which involve balance, agility and coordination, was also recommended. Our physical activity program was in line with these recommendations, being a combined program: aerobic physical activities of moderate or vigorous intensity were completed by step-aerobic classes and High Intensity Interval Training (HIIT), muscle toning and resistance exercises were performed for major musclegroups, and exercises to increase flexibility, balance, agility and coordination were addressed in Pilates classes.

The physical activity program consisted in combined training of Pilates, Step - aerobics and strength training in the gym, 3 times a week for 60-90 minutes, for 12 months.The weekly division was as follows: 2 Pilates sessions of 60 minutes each, followed by 30 minutes of toning in the gym and 1 step-aerobics session/week of 60 minutes, followed by 30 minutes in the gym.

There whereused: dynamic, repetitive exercises, with large muscles groups; hard resistive exercises; functional exercises; high intensity interval training; balance exercises (Pilates); circuit training; stretching exercises.

Muscle strengthening was conducted mainly in the following muscle groups: upper limb muscles, back muscles, abdominal muscles, lower limb muscles.

Results

The analysis of the data of the subjects participating in the study reveals that their average age was 28.45 (8.75) years, the minimum age being 18 years, and the maximum 52 years. The descriptive analysis, by age range, is presented in Table 2.

Table 2. Distribution of subjects according to age range (N = 95)

Age Interval	Frequency	Percent	Valid Percent	Cumulative Percent	Minimum	Maximum	Mean	StDev
<25	41	43,2	43,2	43,2	18	24	21,10	1,828
25-34	31	32,6	32,6	75,8	25	34	28,42	2,527
35-44	14	14,7	14,7	90,5	35	43	37,79	2,887
>44	9	9,5	9,5	100,0	45	52	47,56	2,068
Total	95	100,0	100,0		18	52	28,45	8,746

Of the 95 subjects, 41 (43.2%) were under the age of 25 years, 31 (32.6%) in the age range of 25-34 years, 14 (14.7%) in that of 35-44 years, and 9 (.5%) were over 44 years.

Table 3. Results of the core muscle strength and stability test at the initial and final evaluation (N=95)

Stages	**Completed seconds**	**Grade/Qualifying**	**Initial assessment**		**Final assessment**	
			Nr. subjects	**Percentage**	**Nr. subjects**	**Percentage**
Stage 1	60 sec	Needs improvement	69	72,6%	20	21,1%
Stage 2	75 sec	Needs improvement	1	1,1%	-	-
Stage 3	90 sec	Needs improvement	3	3,1%	26	27,4%
Stage 4	105 sec	Good	4	4,2%	-	
Stage 5	120 sec	Good	13	13,6%	18	18,9%
Stage 6	135 sec	Excellent	-		3	3,1%
Stage 7	150 sec	Excellent	-		10	10,5%
Stage 8	180 sec	Excellent	5	5,3%	18	18,9%
TOTAL			95	100%	95	100%

The results of the coremuscle strength and stability test from the initial and final evaluations, for the whole group can be consulted in Table no.3. We notice that at the initial evaluation, 69 subjects (72.7%) could complete only the first stage of the test, 1 subject (1.1%), the 2nd stage, 3 subjects (3.1%), the 3rd stage, 4 subjects (4.2%) reached the 4th stage, 13 (13.6%), up to the 5th stage, and 5 subjects (5.3%) managed to complete the test . At the final evaluation, 20 subjects (21.1%) completed the first stage, 26 subjects (27.5%), the 3rd stage, 18 subjects (18.9%), the 5th stage, 3 subjects (3.1%), stage 6, 10 subjects (10.5%), stage 7, and 18 subjects reached stage 8 and completed the test.

Table 4. Initial and final evaluation results of the core muscle strength and stability test at the age range <25 years (N = 41)

Stages	**Seconds**	**Qualifying**	**Initial assessment**		**Final assessment**	
			Nr. subjects	**Percentage**	**Nr. subjects**	**Percentage**
Stage 1	60 sec	Needs improvement	28	68,3%	5	12,3%
Stage 2	75 sec	Needs improvement	1	2,4%	-	-
Stage 3	90 sec	Needs improvement	1	2,4%	15	36,6%
Stage 4	105 sec	Good	-	-	-	-
Stage 5	120 sec	Good	8	19,6%	8	19,5%
Stage 6	135 sec	Excellent	-	-	2	4,8%
Stage 7	150 sec	Excellent	-	-	5	12,2%
Stage 8	180 sec	Excellent	3	7,3%	6	14,6%
TOTAL			**41**	**100%**	**41**	**100%**

At the age range <25 years at the initial and final evaluations of the core muscle strength and stability test, the following results came out: initially 28 subjects (68.3%) completed the first stage, 1 subject (2.4) %), stage 2 and 3, 8 subjects (19.6%), stage 5, and 3 subjects (7.3%) reached stage 8 and completed the test. At the final evaluation, 5 subjects (12.3%) completed the first stage, 15 subjects (36.6%), the 3rd stage, 8 subjects (19.5%), the 5th stage, 2 subjects (4.8%), stage 6, 5 subjects (12.2%), stage 7, and 6 subjects (14.6%) completed the test (Table no.4).

Table 5. Initial and final evaluation results of the core muscle strength and stability test at the age range 25-34 years (N=31)

Stages	**Seconds**	**Qualifying**	**Initial assessment**		**Final assessment**	
			Nr. subjects	**Percentage**	**Nr. subjects**	**Percentage**
Stage 1	60 sec	Needs improvement	24	77,5%	7	22,6%
Stage 2	75 sec	Needs improvement	-	-	-	-
Stage 3	90 sec	Needs improvement	-	-	8	25,9%
Stage 4	105 sec	Good	-	-	-	-
Stage 5	120 sec	Good	5	16,1%	7	22,6%
Stage 6	135 sec	Excellent	-	-	1	3,2%
Stage 7	150 sec	Excellent	-	-	3	9,6%
Stage 8	180 sec	Excellent	2	6,4%	5	16,1%
TOTAL			**31**	**100%**	**31**	**100%**

At the age range 25-34 years at the initial and final evaluations of the coremuscle strength and stability test, the following results came out: initially 24 subjects (77.5%) completed the first stage, 5 subjects (16.1 %), stage 5 and 2 subjects (6.4%) reached stage 8 and completed the test. At the final evaluation, 7 subjects (22.6%) completed the first stage, 8 subjects (25.9%), the 3rd stage,

7 subjects (22.6%), the 5th stage, 1 subject 3.2%), stage 6, 3 subjects (9.6%), stage 7, and 5 subjects (16.1%) completed the test (Table no.5).

Table 6. Initial and final evaluation results of the core muscle strength and stability test at the age range35-44 years (N=14)

Stages	**Seconds**	**Qualifying**	**Initial assessment**		**Final assessment**	
			Nr. subjects	**Percentage**	**Nr. subjects**	**Percentage**
Stage 1	60 sec	Needs improvement	10	71,5%	5	35,7%
Stage 2	75 sec	Needs improvement	-	-	-	-
Stage 3	90 sec	Needs improvement	2	14,3%	2	14,3%
Stage 4	105 sec	Good	1	7,1%	-	-
Stage 5	120 sec	Good	1	7,1%	2	14,3%
Stage 6	135 sec	Excellent	-	-	-	-
Stage 7	150 sec	Excellent	-	-	2	14,3%
Stage 8	180 sec	Excellent	-	-	3	21,4%
TOTAL			**14**	**100%**	**14**	**100%**

At the age range 35-44 years at the initial and final evaluations of the coremuscle strength and stability test, the following results came out: initially 10 subjects (71.5%) completed the first stage, 2 subjects (14.3 %), the 3rd stage and 1 subject (7.1%), reachedthe 4th stage, respectively the 5th one. No one managed to pass the 5th stage. At the final evaluation, 5 subjects (35.7%) completed the first stage, 2 subjects (14.3%), reachedthe 3rd stage, the 5th stage, respectively, the 7th stage, and 3 subjects (21.4%) completed the test (Table no. 6).

Table7. Initial and final evaluation results of the core muscle strength and stability test at the age range>44 years (N=9)

Stages	**Seconds**	**Qualifying**	**Initial assessment**		**Final assessment**	
			Nr. subjects	**Percentage**	**Nr. subjects**	**Percentage**
Stage 1	60 sec	Needs improvement	7	77,8%	3	33,4%
Stage 2	75 sec	Needs improvement	-	-	-	-
Stage 3	90 sec	Needs improvement	-	-	1	11,1%
Stage 4	105 sec	Good	-	-	-	-
Stage 5	120 sec	Good	2	22,2%	1	11,1%
Stage 6	135 sec	Excellent	-	-	-	-
Stage 7	150 sec	Excellent	-	-	-	-
Stage 8	180 sec	Excellent	-	-	4	44,4%
TOTAL			**9**	**100%**	**9**	**100%**

At the age range >44 years, at the initial and final evaluations of the core muscle strength and stability test, the following results came out: initially 7 subjects (77.8%) completed the first stage, 2 subjects (22.2 %) stage 5. No one managed to pass the 5th stage. At the final evaluation, 3 subjects (33.4%) completed the first stage, 1 subject (11.1%), the 3rd stage, respectively the 5th stage, and 4 subjects (44.4%) completed the test (Table no.7).

Discussions

At the core muscle strength and stability test, in the initial evaluation only 5 subjects (5.3%) managed to complete the test, so we can say that very few received the excellent grade and had a corresponding strength and stability of the core muscles. Instead, at the final evaluation, 18 subjects (18.9%) completed the test and another 13 (13.6%) received the excellent grade (they reached the

6th and 7th stages, respectively). We must also remember that the test was designed for athletes, but there is no other functional test that examines the overall strength and stability of the core muscles.

A recent study from 2018 by Clark et al. interviewed 241 athletes, coaches, sport science and sports medicine practitioners about their perceptions on anatomy and function of the core, their views on effectiveness of various current and traditional exercise training modes [10]. Respondents were asked to identify the most effective method of measuring core stability in a healthy, uninjured person. Almost a quarter (22%) reported that there was no effective method to test core stability. A number (43%) of the respondents proposed subjective assessment of core stability through observation. Of these, 17% suggested observation of sport-specific movement or exercise technique and 26%, observation of ground-based loaded barbell exercises. Objective assessments were proposed by 32% and included the timed isometric plank (19%), functional movement screen (9%) and isometric trunk bracing with biofeedback (4%).

A 2008 study by Endleman and Critchley provided the first evidence that specific Pilates exercises activate deep abdominal muscles [11]. The researchers used ultrasound scanning to measure the change in thickness of the abdominal transverse and internal oblique when the subjects performed a set of classic Pilates exercises: imprint, the hundred, rolling up, foot circles. They found a significant increase in thickness, representing muscle activity, both in the abdominal transverse and in the internal oblique, during all Pilates exercises performed correctly.

The Pilates method has been shown to improve core endurance [12, 13]

In 2018, Wood's book entitled "Pilates for Rehabilitation - Recover from injury and optimize function" appeared, which presents the science behind the Pilates method for recovery and which claims that the method focuses on the nucleus, center of the body or core [14].

Conclusions

At the core muscle strength and stability test, almost all subjects improved their results: the number of subjects who received the excellent grade increased from 5 (5.3%) at the initial evaluation, to 31 (32.5%) at the final evaluation. So we can conclude that our hypothesis has been confirmed, the combined physical activity program (Pilates, step-aerobics and strength training) having a beneficial effect on core muscle strength and stability.

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