ULTRAZVUČNA PROCJENA FUNKCIJE OŠITA U OSOBA S AKSIJALNIM SPONDILOARTRITISOM

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Aksijalni spondiloartritis (axSpA) je kronična upalna bolest koja pretežno zahvaća kralježnicu i sakroilijakalne zglobove. Promjene u funkciji pluća i poremećaji ventilacije najčešće su posljedica promjena u elastičnosti prsnog koša i torakalne kralježnice. Upalne promjene u zglobovima i entezama, zajedno s osifikacijom zglobova, doprinose smanjenju pokretljivosti prsnog koša tijekom respiratornog ciklusa. Trajna ukočenost prsnog koša pogoršava atrofiju interkostalnih mišića, što povećava opterećenje dijafragme kao glavnog inspiratornog mišića. Kod osoba pogođenih AS-om, pad plućne funkcije obično se manifestira kao restriktivni obrazac, s prevalencijom od 20–57%. Iako su restriktivne plućne promjene kod axSpA često asimptomatske, njihov utjecaj na funkcionalnost i kvalitetu života je neosporiv. Ultrazvuk se koristi kao sredstvo za procjenu funkcije dijafragme mjerenjem zadebljanja mišića i respiratorne pokretljivosti. Tijekom kontrakcije dijafragme, ultrazvučni pregledi kroz subkostalni (SCA) prozor pružaju uvid u kranio-kaudalnu ekskurziju dijafragme. Za dobivanje ovih slika, niskofrekventna sonda ili zakrivljena sonda (2–5 MHz) postavlja se odmah ispod rebrenog luka duž srednje klavikularne i prednje aksilarne linije ili duž srednje i stražnje aksilarne linije. Dijafragma se vizualizira kao hiperehogena linija koja se proteže preko jetre i slezene. Istovremeno, prozor zone apozicije (ZOA) koristi se za promatranje debljine mišića i udjela zadebljanja (TF). Kod interkostalnog pristupa, linearna sonda od 10–15 MHz postavlja se u kranio-kaudalnoj ravnini i okomito na kožu, obično između srednje aksilarne linije ili antero-aksilarne linije unutar 8. do 11. interkostalnog prostora. Dijafragma se pojavljuje kao troslojna struktura koja se nalazi između pleuralne i peritonealne membrane. Mjerenja dijafragme provode se u B ili M načinu rada pomoću kalipera, sa zapisima na kraju izdisaja i na kraju udisaja tijekom dubokog disanja. Boussuges i sur. pokazali su visok stupanj ponovljivosti od strane istog ispitivača (96–94%) i između ispitivača (95–91%) pri mjerenju kretanja obje hemidijafragme tijekom mirnog disanja. Mjerenje debljine dijafragme u M-modu i B-modu pokazalo se ponovljivim u skupini od 66 zdravih ispitanika s koeficijentom ponovljivosti od 0,10–0,15 za M-mod i 0,16–0,26 za B-mod. Koeficijent ponovljivosti ≤0,3 smatran je prihvatljivim. Tijekom dubokog disanja u ležećem položaju, normalne vrijednosti pokretljivosti dijafragme su: za desnu hemidijafragmu: 4,7±1,0 cm (žene) u odnosu na 5,3±1,1 cm (muškarci); v Lijeva hemidijafragma: 4,8±0,3 cm (žene) u odnosu na 5,4±1,3 cm (muškarci). Procjena trofičnosti i kontraktilne učinkovitosti dijafragme uključuje procjenu debljine dijafragme (Tdi), omjera zadebljanja na kraju udisaja i izdisaja (TdTLC/TdFRC) te udjela zadebljanja dijafragme (TF) na kraju forsiranog udisaja (Tdi-insp) i forsiranog izdisaja (Tdi-exp) [(Dtf) = (tdiTLC − tdiFRC)/tdiFRC] u obje hemidijafragme. Referentne vrijednosti za zdrave osobe, temeljene na presječnoj studiji 109 zdravih ispitanika prosječne dobi od 25,8 ± 6,5 godina, iznose 0,14 ± 0,03 cm za žene i 0,19 ± 0,04 cm za muškarce. Donja granica prihvatljive debljine dijafragme pri FRC-u je 0,15 cm, a povećanje debljine dijafragme od FRC-a do TLC-a od najmanje 20% smatra se fiziološkim. Razlika u debljini sa strane pri FRC-u > 0,33 cm je abnormalna. TF se izračunava pomoću sljedeće formule: TF = [(Tdi-insp − Tdi-exp)/Tdi-exp] × 100. Cardenas i suradnici proveli su studiju na uzorku od 64 zdrava sudionika i odredili prosječni fiziološki TF od (169±43)% kod žena i (204±61)% kod muškaraca. Očekuje se da će se dijafragma zadebljati za najmanje 20% tijekom maksimalnog udisaja, s minimalnim varijacijama sa strane na stranu. Dijagnoza disfunkcije dijafragme uključuje ultrazvučne vrijednosti TF-a od 40 kg/m2, koje su povezane sa statistički nižom pokretljivošću dijafragme kod zdravih ispitanika. Ünlü i sur. u komparativnoj studiji s 33 ispitanika s axSpA uočili su neznačajno smanjenje pokretljivosti dijafragme u usporedbi s kontrolnom skupinom pomoću ultrazvuka i pronašli su pozitivnu korelaciju između pokretljivosti dijafragme i udaljenosti od potiljka do zida te negativnu korelaciju s rotacijom vratne kralježnice i modificiranim Schoberovim testom. Ovi rezultati upućuju na korelaciju između ograničene aksijalne pokretljivosti i pokreta dijafragme. Presječna studija Dhahrija i suradnika na 50 osoba s axSpA pokazala je smanjenje debljine dijafragme i korelaciju između debljine dijafragme i parametara plućne funkcije. Utvrđeno je da debljina dijafragme korelira s FVC-om i FVC-om u ležećem položaju, što dodatno potvrđuje korelaciju između ultrazvučne procjene dijafragme i rezultata spirometrije. U presječnoj studiji Mejri Ep Ajili i sur. na 50 pacijenata kojima je dijagnosticiran AS, kod 54% ispitanika utvrđeno je smanjena pokretljivost desne hemidijafragme, a smanjeno zadebljanje dijafragme pronađeno je u desnoj hemidijafragmi kod 56% ispitanika. Studija je također pokazala korelaciju između inspiratorne debljine desne hemidijafragme i FVC-a te FVC-a u ležećem položaju. Korištenje ultrazvučnih mjerenja za kvantificiranje debljine dijafragme, koja, s obzirom na njezinu središnju ulogu kao glavnog inspiratornog mišića, u kombinaciji s procjenom njezine respiratorne pokretljivosti, pružaju objektivan uvid u njezinu funkcionalnu dinamiku. Razumijevanje ovih adaptivnih promjena ključno je za kontinuirano praćenje stanja pacijenata s axSpA kako bi se vodile terapijske intervencije za optimizaciju respiratorne funkcije i poboljšanje ishoda liječenja kod ovih pacijenata.

Ključne riječi

ošit, ultrazvuk, pomičnost, debljina, aksijalni spondiloartritis

ULTRASOUND ASSESSMENT OF DIAPHRAGM FUNCTION IN PEOPLE WITH AXIAL SPONDYLOARTHRITIS

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Axial spondyloarthritis (axSpA) is a chronic inflammatory disease predominantly affecting the spine and sacroiliac joints. Changes in lung function and ventilatory disturbances are most often due to changes in the stiffness and elasticity of the thorax and thoracic spine. Inflammatory changes in the joints and entheses, coupled with ossification and fusion of joints and synchondrosis, contribute to a reduction in thoracic mobility during the respiratory cycle. The persistent stiffness of the rib cage exacerbates atrophy of the intercostal muscles, which increases the workload on the diaphragm as the main inspiratory muscle. In individuals affected by AS, the decline in lung function typically manifests as a restrictive pattern, with a prevalence of 20–57%. Although restrictive pulmonary changes in axSpA are often asymptomatic, their impact on functionality and quality of life is undeniable. Ultrasound is used as a means to assess diaphragmatic function by measuring muscle thickening and respiratory mobility. During a diaphragmatic contraction, ultrasound examinations through the subcostal area (SCA) window provide insights into the cranio-caudal excursion of the diaphragm. To acquire these images, a low frequency phased array or curved array probe (2–5 MHz) is placed just below the costal arch along the midclavicular and anterior axillary line or along the mid and posterior axillary line. The diaphragm is visualised as a hyperechoic line extending over the liver and spleen. At the same time, the zone of apposition (ZOA) window is used to observe muscle thickness and thickening fraction (TF). In the intercostal approach, a 10–15 MHz linear array transducer is placed in cranio-caudal alignment and perpendicular to the skin, typically between the mid-axillary line or the antero-axillary line within the 8th to 11th intercostal spaces. The diaphragm appears as a three-layered structure lying between the pleural and peritoneal membranes. Measurements of the diaphragm are taken in either B or M mode using callipers, with recordings at the end of expiration and at the end of inspiration during deep breathing. Boussuges et al. have demonstrated a high degree of reproducibility by the same examiner (96–94%) and between examiners (95–91%) when measuring the movement of both hemidiaphragms during quiet breathing. Measurement of diaphragm thickness fration in M-mode and B-mode has been shown to be reproducible in a group of 66 healthy subjects with a repeatability coefficient of 0.10–0.15 for M-mode and 0.16–0.26 for B-mode. A repeatability coefficient ≤0.3 was considered acceptable. During deep breathing in the supine position, the normal values of diaphragmatic mobility are: for Right hemidiaphragm: 4.7±1.0 cm (female) vs. 5.3± 1.1 cm (male); v Left hemidiaphragm: 4.8±0.3 cm (female) vs. 5.4± 1.3 cm (male). Assessment of the trophicity and contractile efficiency of the diaphragm involves evaluation of the thickness of the diaphragm (Tdi), the ratio of thickening at the end of inspiration and expiration (TdTLC/TdFRC), and the fraction of diaphragmatic thickening (TF) at the end of forced inspiration (Tdi-insp) and forced expiration (Tdi-exp) [(Dtf) = (tdiTLC − tdiFRC)/tdiFRC] in both hemidiaphragms. Reference values for healthy individuals, based on a cross-sectional study of 109 healthy subjects with an average age of 25.8±6.5 years, are 0.14±0.03 cm for women and 0.19±0.04 cm for men. The lower limit of acceptable diaphragmatic thickness at FRC is 0.15 cm, and an increase in diaphragmatic thickness from FRC to TLC of at least 20% is considered physiological. A difference in thickness from sides at FRC of >0.33 cm is abnormal. The TF is calculated using the following formula: TF = [(Tdi-insp − Tdi-exp)/ Tdi-exp] × 100. Cardenas et al. conducted a study on a sample of 64 healthy participants and determined an average physiological TF of (169±43)% in women and (204±61)% in men. The diaphragm is expected to thicken by at least 20% during maximal inspiration, with minimal side-to-side variation. Technical report by Houston et al. found that the normal right-to-left ratio of maximum diaphragmatic displacements during deep breathing was in the range of 0.5 to 1.6. Diagnosis of diaphragmatic dysfunction includes ultrasound values of TF 40 kg/m2 is associated with statistically lower diaphragmatic motility in healthy subjects. Ünlü et al. in a comparative study with 33 axSpA subjects observed a non-significant reduction in diaphragmatic mobility compared to a control group using ultrasound. and found a positive correlation between diaphragmatic mobility and the occiput to wall distance and a negative correlation with cervical spine rotation and the modified Schober test. These results suggest a correlation between limited axial mobility and diaphragmatic movement. A cross-sectional study by Dhahri et al. in 50 people with axSpA. showed a decrease in diaphragm thickness and a correlation between diaphragm thickness and lung function parameters. Diaphragmatic thickness was found to correlate with FVC and supine FVC, further confirming the correlation between ultrasound diaphragmatic assessment and spirometry results. In a cross-sectional study of 50 patients diagnosed with AS by Mejri Ep Ajili et al., 54% of the subjects were found to have decreased right hemidiaphragm motility and decreased diaphragmatic thickening was found in the right hemidiaphragm in 56% of the subjects. The study also showed a correlation between right hemidiaphragm inspiratory thickness and FVC and FVC in the supine position. The use of ultrasound measurements to quantify diaphragm thickness, which, given its central role as the main inspiratory muscle, combined with an assessment of its respiratory mobility, provides objective insights into its functional dynamics. A nuanced understanding of these adaptive changes is essential for ongoing monitoring of the condition of axSpA patients to facilitate therapeutic interventions to optimise respiratory function and improve treatment outcomes in these patients.

Keywords

diaphragm, ultrasonography, motion, thickness, axial spondyloarthritis

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