In acest editorial, autorii aduc în atenția chirurgilor un punct de vedere personal cu intenția de a oferi o serie de argumente anatomice care să explice rata mare a complicațiilor funcționale consecutive rezecțiilor ultrajoase de rect, rezecții dominate de incontinența fecală cu diverse intensități. Având ca punct de plecare anatomia planșeului pelvin și a perineului posterior, autorii se preocupă de consecințele funcționale ale chirurgiei de rezecție rectală anterioară cu conservarea aparatului sfincterian, cu referire la sindromul rezecției rectale joase și ultrajoase. Tehnic, actualmente s-a ajuns la o chirurgie conservatoare adresată cancerului de rect inferior. Dacă în urmă cu 25 de ani pentru cancerul de rect situat sub 7 cm de orificiul anal se practică amputația de rect, în zilele noastre s-a ajuns la păstrarea canalului anal ca partener pentru anastomoza cu colonul. Progresiv, din dorința de a păstra un tranzit intestinal pe căi naturale, cât mai anatomic și mai fiziologic, rezecția a coborât până la 2-4 cm de orificiul anal și s-au construit anastomoze ultrajoase, în plin aparat sfincterian anal. Scopul declarat: îndeplinirea standardului de siguranță oncologică și, concomitent, evitarea colostomiei definitive. Plecând de la anatomia normală a planșeului pelvin și a segmentului anorectal, autorii fac o incursiune în alterările structurilor viscerale, musculare și nervoase consecința rezecției rectale joase și, mai ales, ultrajoase. Remarcăm un grad ridicat de consecințe funcționale privind defecația, cu instalarea
unor dizabilități marcate ale continentei anale, consecința majoră fiind incontinența anală (30-70%). Autorii inventariză principalele modificări anatomo-fiziologice care acompaniază resecția anterioară a rectului.


Cuvinte cheie: low anterior resection syndrome (LARS), ultralow anterior resection (ULAR), low rectal cancer

Abstract
In this editorial, the authors bring to the attention of surgeons a personal point of view with the intention of offering a series of anatomical arguments to explain the high rate of functional complications following ultralow rectal resections, resections dominated by faecal incontinence of various intensities. Having as a starting point the anatomy of the pelvic floor and the posterior perineum, the authors are concerned with the functional outcomes of the sphincter-saving anterior rectal resection, regarding the low and ultralow resection. Technically, a conservative surgery for low rectal cancer has been currently performed. If 25 years ago the abdominoperineal resection was the gold standard for rectal cancer located under 7cm from the anal verge, nowadays the preservation of the anal canal as a partner for colon anastomosis has been accomplished. Progressively, from a desire to preserve the normal passage of stool into the anal canal, as anatomically and physiologically as possible, the distal limit of resection was lowered to 2-4 cm from the anal verge and ultra-low anastomoses were created, within the anal sphincter complex. The stated goal: keep the oncological safety standard and, at the same time, avoid definitive colostomy. Starting from the normal anatomy of the pelvic floor and the anorectal segment, the authors take a look at the alterations of the visceral, muscular, and nerve structures as a consequence of the low anterior resection and, particularly, the ultralow anterior resection. A significant degree of functional outcomes regarding defecation, with the onset of marked disabilities of anal continence, the major consequence being anal incontinence (30-70%), have been noticed. The authors go under review for the main anatomical and physiological changes that accompany anterior rectal resection.

Conclusions: Thus, the following questions arise: what is the lower limit of resection to avoid total fecal incontinence? Is total incontinence a greater handicap than colostomy or is it not? The answers cannot be supported by solid arguments at this time, but the need to initiate future studies dedicated to this problem emerges.

Key words: low anterior resection syndrome (LARS), ultralow anterior resection (ULAR), low rectal cancer

Introduction
Remarkable progress has been made in the treatment of rectal cancer following the introduction of the total mesorectal excision (TME), mechanical sutures, minimally invasive surgery and radio-chemotherapy. All these relatively new approaches, combined, have led to changes in the surgical attitude, allowing the significant reduction of the tumor recurrence rate, given the fact that surgery has become more conservative by protecting
the anal sphincter complex. To preserve the anal continence and the normal evacuation of feces, thus avoiding the colostomy, the surgeons have significantly lowered the inferior limit of the resection to 3-4 cm and even 2 cm away from the anal orifice. Nowadays, coloanal anastomoses are no longer avoided, being unanimously recommended by the surgeons who treat rectal cancer. Thus, the patient avoids the inconveniences of the definitive colostomy, a genuinely disabling condition that is defined by the legislation as a medium handicap, with psychosocial and economic effects not to be disregarded. Partial or even total anterior rectal resection entails considerable anatomical and physiological changes in the terminal segment of the digestive system. The lower the anastomosis is, the more inconvenient its consequences can be – defecation disorders. Defecation is a personal physiological act, strictly private, which requires good control of the time and space where it takes place. The unpredictability or the urgency of this act can create unpleasant, embarrassing, shameful moments with psychological effects and much more than that. Losing or just altering anal continence, a function acquired in childhood, at the age of 3-4, can generate states of depression, isolation, and loss of self-esteem; concisely, it is perceived as a change in the human condition and an impairment in the quality of life.

However, the progress regarding the oncological result and the reduced sacrifice of the organ have also entailed a disturbance in the quality of the act of defecation meaning the occurrence of more or less expressed impairments of anal continence. These impairments were included in a nosological entity called "Low Anterior Resection Syndrome – LARS". The term LARS was introduced by C. Bryant in 2012 and is intended to define the existence of "intestinal dysfunctions following rectal surgery that led to impairment in the quality of life" (1,2).

The syndrome is relatively heterogeneous, in the sense that it includes many symptoms and their consequences. There are 8 symptoms: frequency of bowel movements, urgency, unpredictable evacuations, changes in consistency, painful stools, difficulty in evacuation, incontinence of matter and flatus. The existence of some of these 8 symptoms can lead to some 8 possible consequences: toilet dependence, preoccupation, dissatisfaction, compromises, decrease of the state of well-being, alteration of social and intimate life, modification of responsibilities (3-7). LARS attempts to define the degree of the alteration of the function of anal continence following anterior rectal resection. „LARS score” uses a questionnaire addressed to the patients, a questionnaire according to which the degree of anal dysfunction may be assessed: no LARS 0-20 points, minor LARS 21-29 points, major LARS 30-42 points. LARS reflects the various degrees of anal incontinence (AI) and the intensity of these defecation impairments - LARS scoring system – according to Emmertsen K.J (3) (Appendix 1).

Pelvic Floor Anatomy

The pelvic floor, also known as the pelvic diaphragm, plays a major role in anal continence. The pelvis is the lower compartment of the abdominal cavity, extending from the line of the iliac crests and the lumbosacral promontory to the pelvic diaphragm of the levator ani which delimit it inferiorly. This anatomical space has the shape of a „washbowl” with a wide upper opening which narrows into a „funnel-shape” structure. Here, the pelvis contains the pelvic organs which are arranged in line, anteroposteriorly: the urinary bladder, the uterus and the appendages, and the rectum. All these viscera are intrapelvic but subperitoneal, and have evacuation ways at the level of the perineum. The subperitoneal pelvis is limited superiorly by the pelvic parietal peritoneum and inferiorly by the” funnel-shape” structure of the levator ani and the coccyx muscle which close the pelvic excavation. This anatomical space is also called the pelvic-subperitoneal or superior perirectal space. Finally, caudal to the levator ani, there is the lower perirectal space delimited inferiorly by the perineal aponeuro-
roses which allow the passage of the urethra, vagina and anal canal. The anterior perineum (the urogenital diaphragm) has four muscles in its constitution, but it does not interfere with the operative act of rectal resection. The posterior or anal perineum is represented by the external anal sphincter which encases the anal canal for 2-3 cm and has three segments: deep, intertwined with the fibers of the puborectal bundle from the levator ani, a middle segment inserted on the sacrococcygeal ligament and a superficial segment inserted on the fibrotendinous nucleus of the perineum.

**The Pelvic Diaphragm (Levator Ani)**

This structure is common to both sexes. In the structure of the diaphragm, there are 2 muscles: the levator ani muscle and the coccygeal muscle. These structures delimit the pelvic cavity from the perineal space (inferior perilctal) and contain the anal canal. The levator ani muscles are composed of very important fascicles for the statics and function of the pelvic organs: the pubovaginal (pubo-prostatic) fascicle and the puborectal fascicle in the internal sector, and the pubic and iliococcygeal fascicles in the external sector. These latter fascicles are completed with fibers deriving from the coccygeal muscle (Fig. 1). This muscular complex fulfills important functions of sphincter and anorectal synergism. The pelvic diaphragm through the puborectal bundle ensures the "securing" of the lower rectum and the creation of the anorectal angle with the role of a valve. In light of these anatomical data, it is obvious that the operative act of resection which descends below the funnel of the levator ani muscle will be carried out with more or less marked alterations of the levator ani (the puborectal fascicle), of the external anal sphincter (the deep segment) and the internal anal sphincter (the upper segment).

The anal continence is dependent on keeping the pelvic diaphragm and the anal sphincter system as intact as possible, simultaneously preserving the critical neurological areas that are responsible for the innervation of the organs in the pelvic "washbowl" (8-16).

**Comments and Discussions**

Among the symptoms of LARS, the most difficult for patients to bear are: frequency of stools, anal incontinence for gas and seepage of stool, fecal urgency and incomplete evacuations (5,7,17,18) It is obvious that there has been a previous concern for AI following surgery. There are at least 3 other scores that aim to evaluate this anal dysfunction: the Wexner score, the Vaizey score and the BFI score (bowel function instrument). The Wexner score (The Cleveland Clinic Fecal Incontinence Severity Scoring System - CCIS) has a scale from 0-20, where 0 points are perfect continence and 20 points are complete incontinence. The Vaizey score (St. Mark's incontinence score) is 0-24 points. The BFI score was proposed by The Memorial Sloan Kettering Cancer Center Bowel Function Instrument - MSKCC BFI and it also measures the anal sphincter dysfunction following sphincter sparing surgery (19-27).
Romania, the legislation established criteria and norms for the assessment and classification of the degrees of disability (28). According to these norms, “anal incontinence is a chronic condition resulting from the inability to effectively restrict the passage of fecal stools through the anal canal, leading to involuntary defecation”. It is therefore a severe impairment of the quality of life, generating stress for the patient and his entourage. In the Romanian legislation, which uses the Wexner and Vaizey scores for evaluation, AI is classified as a medium impairment. That is, an adaptive capacity of 50-69% - this percentage expresses the possibility of adapting to the social environment, compared to a normal adaptive capacity of 100%. AI requires health services for curative treatments, and the disability considerably affects social and intimate relationships, modifying the behavior and daily schedule, and causing a 50% reduction in work capacity (28). According to this classification, AI is considered to be a third-degree disability. Mention should be made that the rules for classifying the degree of disability issued in 2011 placed AI in the second degree of disability, with a total loss of work capacity and a contraindication for any professional activity. Nota bene – colostomy is classified as severe disability (second degree), without the right to work. It results that both permanent colostomy and AI fall under disability, but in different degrees (29). What do LAR (Low Anterior Resection) and ULAR (ultralow anterior resection) aim to achieve? First of all, to remove the rectum affected by the tumor within the limits of oncological safety and, secondly, to maintain the intestinal transit under normal conditions, avoiding definitive colostomy.

Researching the literature, the following percentages of severe LARS (major 20-42 points) are recorded: Croese A.D. (2) - 42%, Emmertsen K.J. (3) - 46%, Wang A (6) - 35%, Juul T. (18) - 32%, Dilke S.M. (30) - 53.4%, Chatwin N.A. (31) - 47%, Ahmad Sakr (32) - 49.01% (76% intersphincteric resection, 49.31% ULAR), Fernandez-Martinez D. (33) - 36.9%. It is noticed that AI after LAR and ULAR is found at an average frequency of 35-50% in the most important statistics. At the same time, according to Fernandez, the symptoms that do not remit after 1 year persist, and 47.5% of the patients are symptomatic 13.7 years after monitoring. Ahmad states that he recorded 75.9% AI after intersphincteric resection and 49.3% after ULAR, and Chatwin estimates that 47% of the patients have major AI and 9% have incontinence (32,33). These percentages reveal that LARS constitutes a complete lot of discomforts that can occur after low and ultralow resections of the rectum, and among them, AI is distinguished as the most debilitating condition. At least during the first 12-18 months postoperatively, major LARS is seen with percentages of 30-50%. It can also be noticed that as the exeresis extends caudally, the percentage of LARS also increases, especially, its severity. The ultralow, coloanal anastomoses are those that provide the highest percentages of major and unrecoverable LARS over time. If after ULAR, major LARS is recorded in 49.3% of the cases, after intersphincteric anastomoses it can reach an incidence of defection impairments of 75.9% (32). The persistence of LARS more than 1 year postoperatively signifies, in general, the continuance of the presence of this syndrome in the following years, 47.5% of these patients having LARS even after 13.7 years of postoperative monitoring (33). If 27% urinary dysfunctions and 30% sexual dysfunctions are added, an unsatisfactory picture is obtained in terms of the functional outcomes after LAR and, especially, ULAR (34).

Quality of Life (QoL) expresses the degree to which a person is healthy, comfortable and able to participate and enjoy the events of life”. This definition has a high degree of ambiguity because the perception of QoL is different from one individual to another, each having personal standards for assessing QoL (35). The quality of life is a strictly subjective measure for assessing „happiness” following individual preferences. The notion includes both health criteria and social, family, professional and financial life conditions. In our field of
interest, the health care field, the assessment of QoL involves ratings of the impact of the disease, the treatment and the patient’s status. WHO (The World Health Organization) (35) defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. This is neither the place nor the time to examine the disputed issue of QoL. However, the inclusion in the QoL definition allows the placement of LARS in the category of discomforts that occur as a result of the impairments produced by the surgical act and thus places the syndrome in the degree of disability (handicap). For a better understanding of the causes of LARS, an analysis of the anatomical and physiological changes occurring following low and ultralow rectal resections is required.

**Consequences of ULAR**

Fundamentally, ULAR involves the total resection of the rectum and the mesorectum to achieve the oncological objectives. As a consequence, the following changes in the anatomical structures are recorded:

a. The complete absence of the rectum;
b. The destruction of some muscular structures in the pelvic floor;
c. Possible injuries of the plexus and pelvic nerve structures.

The effect of neoadjuvant radiation therapy on the anatomical, sphincteric and nerve elements that ensure anal continence should be added to these newly created conditions. Radiation proctitis occurs in a percentage of up to 20%: rectal pain and tenesmus, impetuous stools and sometimes fecal incontinence (36-38). These disorders attributable to radiotherapy appear at least 6 months after irradiation and are caused by damage to the microvascular endothelium. Radiotherapy and the low level of the anastomosis (< 6 cm) have been associated with the alteration of anal continence (37).

a. The complete absence of the rectum is followed by the restoration of transit through a coloanal anastomosis. Thus, the function of being a reservoir, of receptive relaxation of the rectum, disappears, this function being insufficiently compensated by its partner, the anastomotic colon. The absence of the rectum disrupts sensory perception with a major role in ensuring continence as well as normal evacuations. The diminished perception of the neorectum (the colon) is registered in approximately 60% of the patients (39). Rectal compliance cannot be replaced by the adaptive capacity of the anastomotic colon. The recto-colonic inhibitory reflex is cancelled, as well as the excitatory one. The inhibitory reflex causes the relaxation of the internal anal sphincter in response to the rectal distension. The components of the aforementioned reflux are cancelled by the posttraumatic surgical or neurological injuries. At the same time, there is a nerve disconnection between the anastomosed colon and the anal canal. A dyssynergia is established in the sphincter activity. The residual pressure regime of the internal sphincter is disturbed, which decreases during periods of rest, while the external sphincter controls only voluntary continence (40). Thus, a decrease in the involuntary control of anal continence occurs. On the other hand, in patients with LARS, fecal incontinence in its various forms and intensities is much more frequent than constipation. The high-pressure zone of the anal canal is the essential element in ensuring continence. The length of the anal canal is essential in maintaining involuntary sphincter control (41,42). Aside from that, the anorectal ring, along with the flap valve, contributes to continence to a lesser extent. The puborectal bundle, the median segment of the levator ani funnel, maintains the angulation between the anal canal and the overlying rectum, additionally generating a check valve effect (41). The anatomical anal canal is 3 cm long, up to the dentate line. However, surgical anatomy claims that there is sphincter activity on another 2 cm above the dentate line, which means that a total length of 5 cm of the anal canal can be
considered · 3 cm of the anatomical canal and 2 cm of the physiological canal (41,43). LAR places the anastomosis 4-5 cm away from the anal verge, essentially 1-2 cm above the dentate line, practically removing the rectal reservoir completely and cancelling the physiological area of the anal canal. ULAR is even more radical, saving only 2-3 cm of the anatomical anal canal, placing the coloanal anastomosis within the sphincter complex, destroying the puborectal strap from the levator ani and sacrificing the upper segment of the internal sphincter.

b. The destruction of some muscular structures in the pelvic floor and the alteration of the sphincter complex. Given the absence of the rectal reservoir, LAR and ULAR are able, by lowering the resection, to determine changes in the pelvic floor with the disruption of the levator ani functions and the reduction of the anal sphincter apparatus. A weakening of the pelvic diaphragm results in the descent of the perineum (descending perineum syndrome) and, consequently, of the anal canal below the pubococcygeal line, which induces insufficient anal containment (44,45). On the other hand, the puborectal muscle, part of the levator ani muscles, is an essential component of the pelvic diaphragm, encasing the rectum at the anorectal limit, near the dentate line. The puborectal bundle is essential in ensuring the quality of continence. At the moment of defecation, this muscle relaxes and allows the ano-rectal angle to be erased with the deflection of the anal sphincters. The lowering of the resection below the dentate line is responsible for the „breaking“ of the puborectal bundle, concurrently with the destruction of the deep segment of the external anal sphincter and the reduction of the upper pole of the internal sphincter (30,33,34,39-42,46).

c. Injuries to nerve structures. Both surgery and radiation therapy can cause injuries to the nerve structures responsible for the complexity of normal defecation. Thus, the inferior rectal nerve, a branch of the pudendal nerve (S2-S4), provides the motor innervation of the external anal sphincter and the sensory innervation of the lower 1/3 of the anal canal, below the dentate line. Essentially, it ensures the voluntary continence. It is clear that if the resection is performed below the dentate line, the terminal branches of the inferior rectal nerve are intercepted and thus the sensitivity of the remaining anal canal is making possible the uncontrolled evacuation of gas and feces. Besides these inherent nerve interferences attributable to LAR and ULAR, there is also a series of possible injuries of the nerve structures during a rectal resection performed by a surgical team less trained in this type of surgery. Consequently, injuries to the hypogastric nerves and the inferior mesenteric (pelvic) plexus may occur (47). All these possible injuries may occur while performing the rectal-mesorectal resection, thus adding them to the unavoidable nerve injuries during LAR and ULAR. By synthesizing, the following percentages of morbidity are obtained after LAR and ULAR: major LARS up to 26%, stenoses and/or anastomotic fistulae 16%; in total a percentage of 42% of complications (48-51). Because in 80% of the patients undergoing LAR or ULAR a temporary protective ileostomy is also associated, the complications of this surgical procedure will be added as well: the prolapse or retraction of the stoma, stenosis, parastomal infections, and occlusions. These are registered with a non-negligible frequency – 16-20%. In 11.6% of ostomy patients, reoperation is necessary to correct the complication (52). Likewise, closing the ileostomy imposes a new surgical procedure that has its possible complications: parietal abscesses, occlusions, stenoses, and eventrations. Fistula complications after closing the ileostomy alone have a frequency of 6.3% (53,54). Totalling the number of complications after ULAR
with protective ileostomy a percentage of approx. 50% of the patients who will have a complicated evolution are recorded (55-58).

What are the consequences of post-surgical AI? Some of them: are fear, highly affected daily activities, isolation and frustration, humiliation and, finally, depression. There is a rich array of procedures aimed at improving the degree of incontinence. Starting with a diet change up to low-tech biofeedback procedures to train the muscular ligamentous structures of the pelvic floor. Other procedures include the electrostimulation of the sacral nerve to determine an increase in the anal sensitivity and the activity of the external anal sphincter. These first-line approaches, with medical and behavioural treatments, frequently do not give the expected results. Furthermore, if these non-surgical techniques did not prove satisfactory, the following procedures were undertaken: placing an artificial anal sphincter and/or anal graciloplasty and/or myorrhaphy of the levator ani muscles and reconstructions of the external anal sphincter. Unfortunately, after the above-mentioned rehabilitation techniques, only 23.8% of the AI patients no longer presented symptoms, and 42% remained with a third-degree disability with serious impairments and severe disability. Moreover, it was found that anal pressure remains unchanged, at low values, after the anal continence rehabilitation procedures (59). A study conducted by F. Pucciani in 2018, based on the exploration of 169 persistent post-surgical AIs over 27 months found that urge incontinence was present in 82.2% and passive incontinence in 26%, structural defects of the external anal sphincter in 33.1%, defects of the internal anal sphincter in 44.3% and associated sphincter lesions in 23% (60).

All this display of the complications peculiar to LAR and, especially ULAR, is not a reason to justify disregarding rectal conservative surgery. It should be noted that currently, to appreciate the expertise of a surgical department in the surgical treatment of rectal cancer, the essential criterion is the percentage of abdominal perianal resections (APRs). The high percentage of APR qualifies that department in the lower class of surgical performance (19). But, what about the percentage of severe LARS with fecal incontinence responsible for marked disability with severe damage to the patient's life? In what class does the surgeon who registers percentages of 30-40% severe AI qualify? The review of LAR and ULAR morbidity only aims to express a real situation, not an enhanced one, of the results of these surgical interventions. There is a limit at which conservative surgical procedures of the anal sphincter apparatus should no longer be indicated. What should this limit be? We believe that the anastomoses placed less than 4 cm distance from the anal verge do not offer a functional guarantee of quality, rather being perineal colostomies, with no possible prosthesis, impossible to be cared for, and with a major impact on the quality of life. Anal incontinence, in such ULAR cases, occurs in approx. 50% of the patients, being a major, if not severe debilitating condition. Abdominal colostomy is much easier to care for than fecal incontinence which leads to serious psychosocial changes in the patient's life.

The authors intend to make surgeons aware of a reality that, we believe, has been given too little attention. AI is, by no means, a major disability. It entails consequences serious enough to prompt a re-evaluation of the therapeutic act generating this invalidity. Is ultra-low resection surgery responsible for over 70% of AI, and 30-40% of these are with severe, irreducible disability? (61-63). In these circumstances, given these reports, should it be recommended that the act of rectal resection not be followed by a coloanal anastomosis - an anastomosis less than 4 cm away from the anal orifice? We do not wish to question the need to preserve, as much as possible, a part of the anorectal segment in rectal cancer surgery. Nevertheless, the only questionable part is represented by the ultra-low descent, too low, of the anastomosis and its placement within the anal canal, with the risk of anatomical and functional damage to the sphincter apparatus. A patient with severe AI,
specific to coloanal anastomosis, will have a significant limitation of his/her freedom of movement, being dependent on the permanent proximity of a toilet where he/she can ensure personal hygiene.

Conclusions

The question remains: is it worth creating a coloanal anastomosis less than 4 cm away from the anal verge? The answer may be yes. But it may as well be no. The responsibility lies with the surgeon and, obviously, with the patient who should be very correctly informed about the possible disabilities and invalidities following the ultralow coloanal anastomosis. It is natural that the material proposed by us offers the possibility of a debate, which we really believe is necessary.

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The authors declare that they have no conflicts of interest. No funding or not able to provide at the moment.

References

Supplementary Material

Appendix 1. LARS scoring system – according to Emmertsen K.J. (3)

LARS-score - Scoring Instructions
Add the scores from each 5 answers to one final score

Do you ever have occasions when you cannot control your flatus (wind)?

☐ No, never 0
☐ Yes, less than once per week 4
☐ Yes, at least once per week 7

Do you ever have any accidental leakage of liquid stool?

☐ No, never 0
☐ Yes, less than once per week 3
☐ Yes, at least once per week 3

How often do you open your bowels?

☐ More than 7 times per day (24 hours) 4
☐ 4-7 times per day (24 hours) 2
☐ 1-3 times per day (24 hours) 0
☐ Less than once per day (24 hours) 5

Do you ever have to open your bowels again within one hour of the last bowel opening?

☐ No, never 0
☐ Yes, less than once per week 9
☐ Yes, at least once per week 11

Do you ever have such a strong urge to open your bowels that you have to rush to the toilet?

☐ No, never 0
☐ Yes, less than once per week 11
☐ Yes, at least once per week 16

Total Score:

Interpretation:
0-20: No LARS
21-29: Minor LARS
30-42: Major LARS