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Study on the Characteristics of Dynamic Deformation of Various Parts of Human Body and their Influences on Clothing

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Abstract:

It is necessary to study the function of human motion system. Only by mastering the law of human dynamic deformation can we master the state and method of clothing overall deformation. The skin has strong following. By studying the skin stretching movement formed by human movement, the comfort of clothing will be better determined. By studying the dynamic characteristics of human body, this paper understands the close relationship between human body dynamic deformation and clothing deformation, so as to make clothing more fit.

Keywords*: Datahuman body, Dynamic deformation, Clothing dynamics analysis.*

As the saying goes, we should cut the dress according to one's figure.It will be easier to make fit clothing for the stationary human body. However, the human body is often in a state of movement, so the shape change of the human body becomes complicated, and problems related to fitness and comfort of clothing will often occur. Only by fully understanding the various sports functions of the human body can we study the deformation law of human skin during sports and analyze the influencing factors of clothing structure and fabric. In sum, it is vitally important to study the function of movement system of human body. To master the whole deformation state of clothing, we must master the approaches and methods of the research on human body's dynamic deformation.

I. THE MOVEMENT SYSTEM OF HUMAN BODY

The movement system of human body is mainly composed of bones, joints and muscles. Bones are the lever of movement. Joints are the hub of movement. Muscles are the force of movement.

1.1Bones

1.1.1 Composition of bones

Bones play the role of supporting. They make the body stand firm and keep the basic shape of human body; they also have the function of protecting important organs in the body. There are 206 bones in the

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human body, which are divided into three parts: skulls, trunk bonesand limb bones. The skulls consist of 29 bones of cerebral cranium and facial cranium, 51 trunk bones and 126 limbs bones.

1.1.2. Bone position related to clothing anthropometry(as shown in Fig 1)

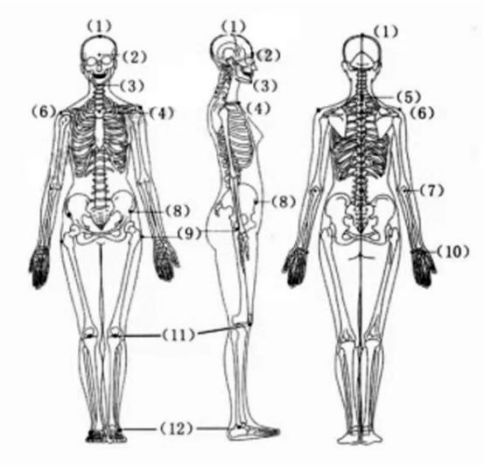

Fig 1:Main landmarks on human bones

(1) The top point

(2) Point between the eyebrows

(3) Mandibular point

(4) Median anterior clavicle point

(5) The seventh cervical vertebra point

(6) Acromion point

(7) Elbow point

(8) Intestinal spine point

(9) Greater trochanterpoint

(10) Point of styloid process of ulna

(11) Median knee point

(12) Lateral malleolus point

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1.2 Joints

Joints move around axes. According to the movement direction,they can be divided into: uniaxial joints (X or Y directions), biaxial joints (X and Y directions) and multiaxial joints (X, Y and Z directions). According to the orientation of the joint movement axis (as shown in Figur 2), there are five types of movement: bending and stretching, stretching and contraction, rotation, circumduction and horizontal bending and stretching.

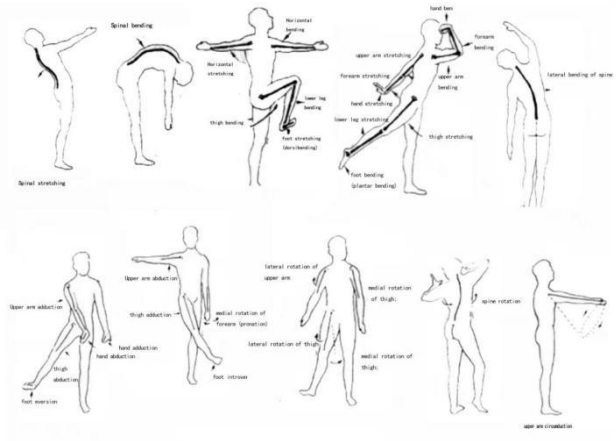

Fig 2: Movement of human joints

1.3 Muscles

There are more than 600 muscles in human body, which can be roughly divided into three types: skeletal muscles, smooth muscles and cardiac muscles. Musclesare characterized by contraction and relaxation. In addition to bones, joints and muscles, there are ligaments that restrict joint movement. Therefore, there is certain limit on the activities of human body[1].The activities beyond the limit will cause damage to the human body (TABLE I).

TABLE I. Table of comfortable adjustment range of movement of important parts of human body

Body parts	Joint	Activities	Maximum angle	Maximum range	Comfort adjustment range
Head to trunk	neck joint	lowering the head;	40	75	+12 —-15
		raising the head	-35		

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		Head tilting towards the left	55	110	0
		head tilting towards the right	-55		
		head turning towards the left	55	110	0
		head turning towards the right	-55		
trunk	thoracic joint lumbar joint	forward bending	100	150	0
		backward bending	-50		
		left-handed rotation	50	100	0
		right-handed rotation	-50		
		turning towards the left	50	100	0
		turning towards the right	-50		
thigh to hipjoint	hip joint	forward bending	120	135	0
		backward bending	-15		
		abduction	30	45	0

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		adduction	-15		
lower leg to thigh	knee joint	forward swing	0	135	0
		backward swing	-135		
foot to lower leg	foot joint	Upswing	110	55	+85——+95
		downswing	55		
foot to trunk	hip joint lower leg joint Footjoint	outward turning	110	180	+0 —— +15
		inward turning	-70		
upper arm to trunk	shoulder joint (clavicle)	Out-swing	180	210	0
		Inner-swing	-30		
		Upswing	180	225	+15——+35
		downswing	-45		
		forward swing	140	180	+40——+90
		backward swing	-40		
forearm to upper arm	elbow joint	bending	145	145	+85——+110
		stretching	0		
hand to forearm	wrist joint	Out-swing	30	50	0
		Inner-swing	-20		
		bending	75	135	0
		stretching	-60		
hand to trunk	shoulder joint forearm	turning towards the left	130	250	-30—— -60
		turning towards the right	-120		

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II. MOVEMENT OF VARIOUS PARTS OF HUMAN BODY

2.1 Trunk Movement

2.1.1. Neck

As the articular surface of the cervical vertebra is close to horizontal, the neck can rotate inside and outside, and move in multiple angles and directions, mainly including forward bending, backward stretching, lateral bending, external rotation and other movements. (Fig 3) These movements directly affect the shape of the collar and its movement functionality.

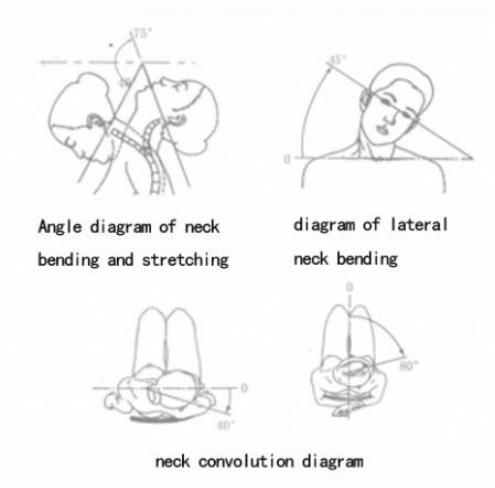

Fig 3: Diagram of neck movement range

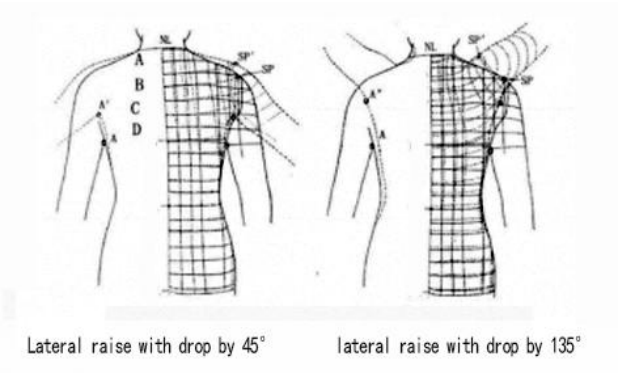

Fig4:Diagram of back movement range

2.1.2 Back

In daily life, the common movements and posturesinclude upper limb lifting, arm folding across the chest, which all leads to back expansion. It can be seen that the back expansion is often integrated with the upper limb and shoulder movements. (Fig 4) shows the back expansion and skin displacement caused by upper limb movement, and the change of back length during right upper limb movement[2-3].

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2.1.3 Chest (as shown in Fig 5)

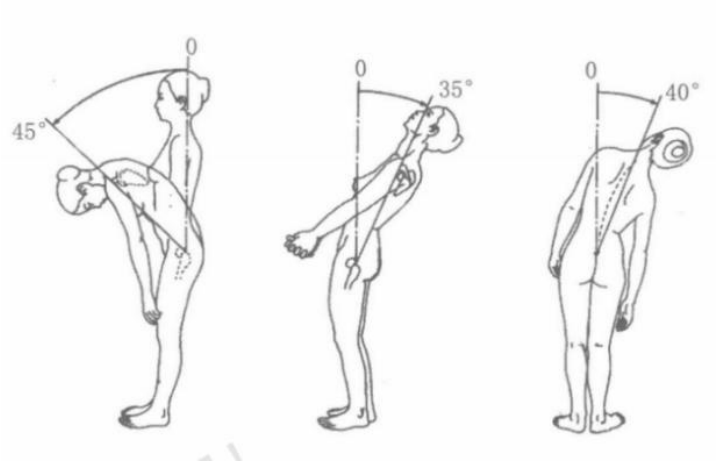

Fig 5: Changes of chest direction

2.1.4. Spine

The spine is composed of cervical vertebra, thoracic vertebra and lumbar vertebra, in which the curvature of the thoracic and lumbar spine directly affects the deformation of the skin on the back, chest and abdomen of human body, leading to the compression of clothing on the back of human body and the traction of armpit (Fig 6).

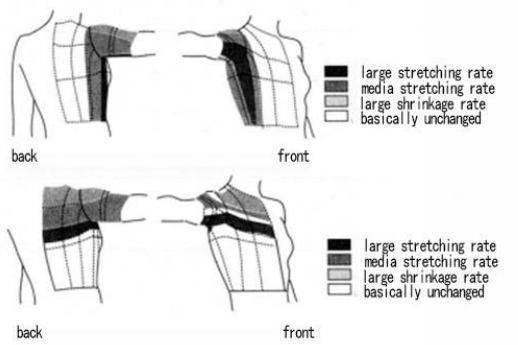

Fig6:Skin deformation caused by spine movement

2.2 Upper Limb Movement

2.2.1. Structure of upper limb

The upper limb is composedofpectoral girdles and free upper limb bones. The pectoral girdle consists of clavicle and scapula, while the free upper limb bone consists of ulnaof humerus and forearm, radius, hand root bones and phalanx[4].

2.2.2. Directionality of upper limb

In the movement of upper limbs, the sternoclavicular joint is the fulcrum, and the acromioclavicular joint

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also cooperates with the shoulder joint to move together, so that the upper limb can be raised to the position close to the head when moving up and down. According to the range of movement, the upper limb movement mainly includes the movement of shoulder joint, elbow joint and wrist joint. Each fulcrum has a certain range of movement (Fig 7).

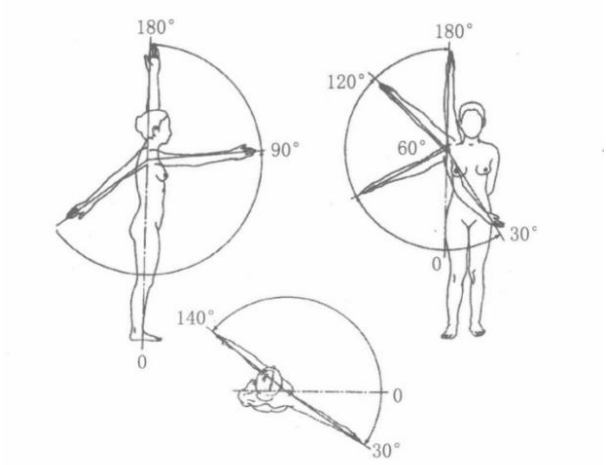

Fig 7:Movement of shoulder joint

(1) Shoulder joint

Shoulder joint is a multiaxial ball joint connecting the head of humerus with the glenoid fossa of the scapula, which can move freely in many directions. Its range of movement is shown in (Fig 8). As can be seen from the figure, the front-back movement at the acromion and the up-and-down movement at the acromion directly affect the shouldershape of the clothing. The range of front-back and up-and-down movement at the acromionis shown in (Fig 9).

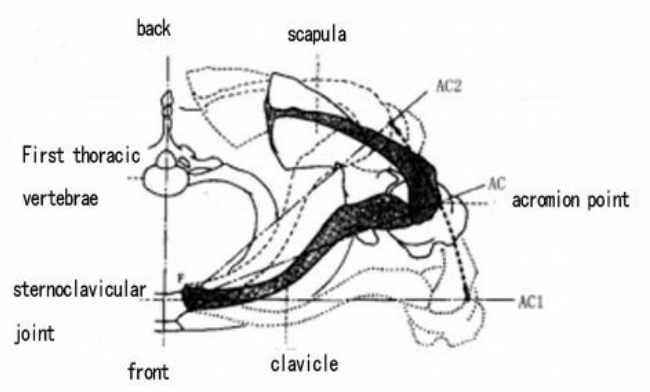

Fig 8:Front-back movement range of acromion

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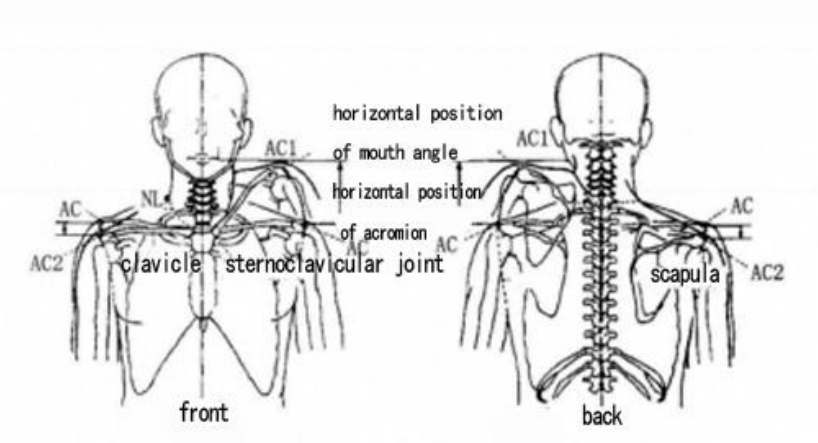

Fig 9:Up-down movement range of acromion

(2) Elbow joint

The elbow joint is a uniaxial joint, so it can only bend forward, but can not bend backward, with bending angle ranging from 0° to 145°.Furthermore, the movement of the joint at the upper end of ulna and the upper end of radius can form the inward and outward twisting movement of forearm, which directly affects the tightness of sleeves (Fig 10).

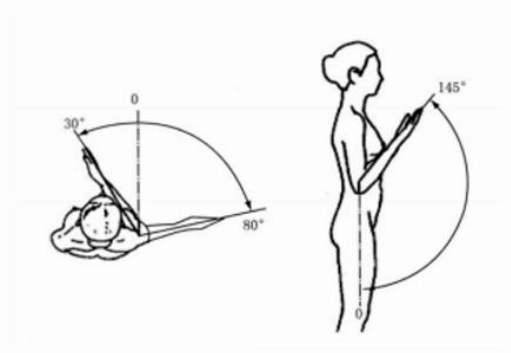

Fig 10:Movement of elbow joint

(3)

(4) Wrist joint

The intercarpal joint consists of the distal side of the proximal row of carpal bones and the proximal side of the distal row of carpal bones, with relatively small movement range (Figure 11).

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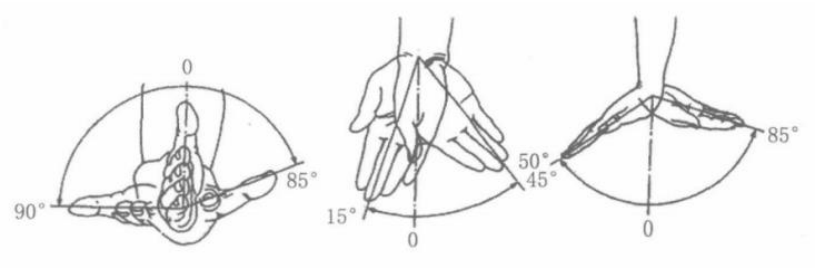

Fig 11:Movement of wrist joint

2.3 Lower Limb Movement

2.3.1. Structure of lower limb

The lower limb bone consists of lower limb girdleand free lower limb bone. Among them, the lower limb girdlemainly consists of marrowbone, and the free lower limb bone consists of femur, marrowbone, tibia, fibula and foot bone[5]. Generally speaking, the lower limb bone is composed of pelvis (pubis, marrowbone), femur, focile and foot bone.

2.3.2. Directionality of lower limb

According to the range of movement, when the lower limbs are moving, there are two fulcrums, namely femoral joint and knee joint, which are closely related to trousers. Each fulcrum has a certain range of movement.

(1) Femoral joint

The femoral joint is multiaxial joint, and the femoral head is a 3/4sphere. With the femoral head as the center, the legs can move in multi-axis directions. Generally speaking, each axis of femoral joint can move independently, and at the same time multi-axis movement can also be realized, thus forming the three-dimensional movement range of lower limbs. The bending and stretching of the femoral joint directly affects the traction and compression of trousers from the inner thigh to the waist (Fig 12).

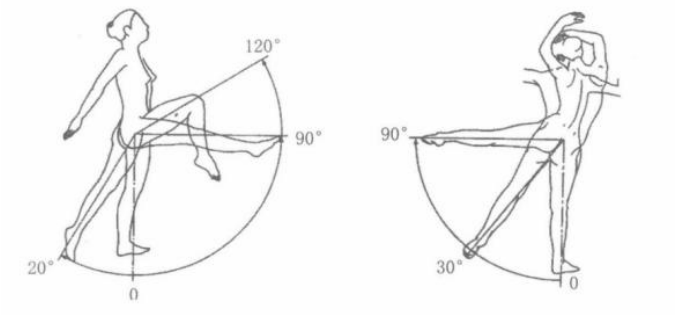

Fig 12:Movement of femoral joint

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(2) Knee joint

The knee joint is a uniaxial joint, so it can only bend in the front-back direction (the range of movement of the knee joint from stretching to bending is 135°), which directly affects the traction and compression of the knees of trousers[6]. When the femoral joint moves, it is often accompanied by the movement of the knee joint, which makes the movement range of lower limbs wider (Fig 13).

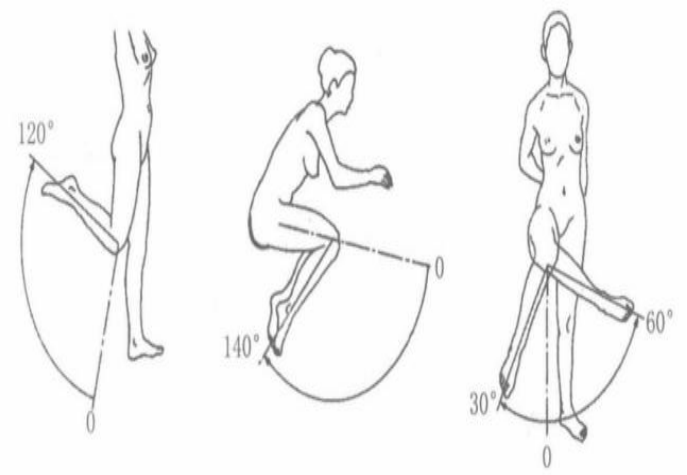

Fig 13:Movement of knee joint

III.SKIN STRETCHING CAUSED BY HUMAN BODY MOTION

In the process of human body motion, especially the upper limbs and lower limbs, the skin has a strong following performance. The comfort of clothing is determined by studying skin dividing line and skin field. The skin dividing line constitutes the fiber direction of the skin, which is equivalent to the warp direction of the fabric. The skin field is the whole skin formed by skin bumps. The skin stretching is generally perpendicular to the skin dividing line direction. It is precisely because of frequent repeated stretching that wrinkles are formed along the skin secant direction. The wrinkles formed by tissues and the wrinkles formed by movement savings overlap each other, which makes the wrinkles more obvious and clearly shows the stretching direction. The most important is to know the direction of increasing the amount of movement when these human body motion functions are transformed into patterns. In terms of clothing, the surface needs a certain amount of movement, and at the same time, the reasonable slippage of clothing should also be considered. Professor Nakazawa, from Japan, divided human functions into four functional areas from the perspective of clothing design[7](Fig 14).

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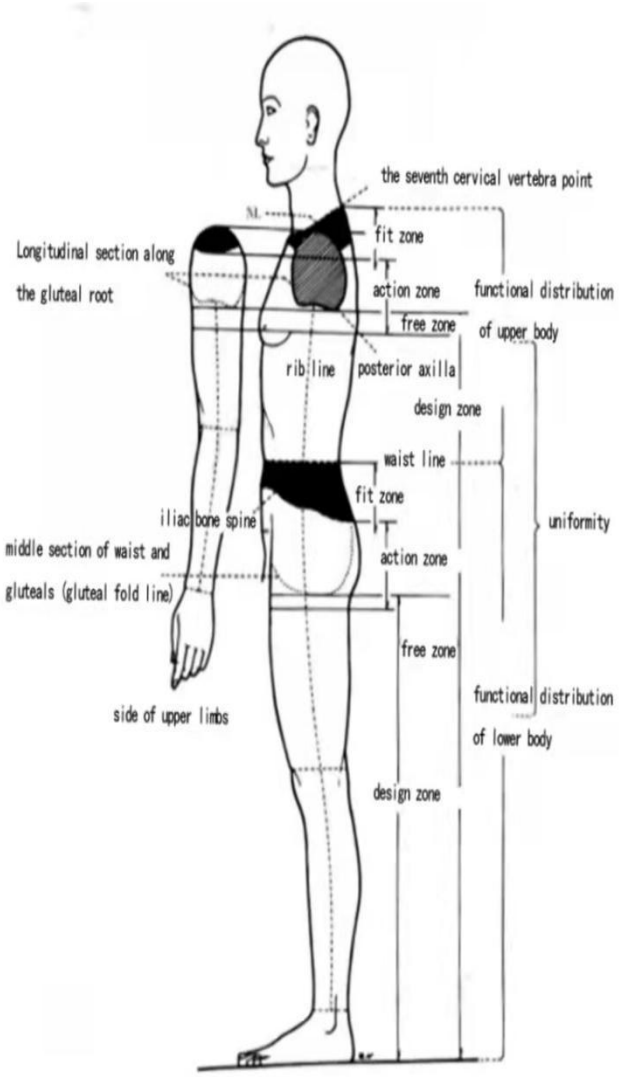

Fig 14: humanfour functional areas

3.1Fitting Area

The fitting area is an important position of clothing shape, a supporting point and a supporting belt for clothing, which is of great significance to the sense of wearing, fitness and drape effect of clothing.The upper body fitting area refers to the protuberant part of the anterior sternoclavicular joint, the anterior clavicular bend, the upper arm bonefrom the posterior scapula to the spinous process, based on collar girth and shoulder line. It is roughly the range of the mesh part in the figure. The lower body fitting area is supported by the waist line, covering the front lower abdomen, the lateral anterior iliac spine and the rear hip. It is also the fitting area of trousers and skirts at the waist, requiring fitness. The upper limb fitting area is a small mesh area below the acromion point, which is roughly the area where the sleeve top fits the shoulder circle. The fitting area of lower limbs is a close fitting area formed by skirts and waistbands of trousers, which is the part for fittingstudy.

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3.2 Action Area

The action area is the area that reflects the functionality of clothing. If this areais not handled well on the pattern, uncomfortable feelings such as traction and compression will appear in the finished clothing.

The upper body action area is between the fitting area and the armpit free area, including the front and rear armpits which are taken into serious consideration to adapt to the movement of upper limbs, that is, the movement function range involving the chest width, back width, armhole and armhole depth of the clothing. The action area of the lower body is between the fitting area and the free area of the gluteal bottom, including the gluteal fold part adapted to the bendingof lower limbs. In terms of trousers, it is the amount of cylindrical gap covering the thigh root, the degree of inclination near the hip of the back piece of trousers, the shape of the crotch arc, and the range of adjusting and improving the movement adaptability. The action area of upper limbs is the most intense area of the movement with the armpit as the center. The movement function is adjusted by the height of the sleeve top[8]. The action area of lower limbs includes the parts of gluteal fold and gluteal bottom which are easy to shift, and it is the central part to consider the movement function of trousers.

3.3 Free Area

The upper body free area is the horizontal band-shaped area of the armpit (the upper armpit free area on the pattern is 5cm-6cm). In pattern design, the armhole depth is basically set together with the bust relaxation. At the same time, the armhole depth is adjusted from the functional perspective. That is to say, in this range, armhole lines can be designed and moved freely, which not only promotes the modeling of armholes, but also contains the germination of new patterns. The lower body free area is the belt-shaped part under the gluteal fold (the free area under the gluteal foldon the pattern is 2cm-3cm), which is mainly the area where the gluteal fold, the front and rear cross crotch connection and the glutealbottom relaxation can be freely adjusted[9]. The upper limb free area is the space below the posterior armpit, that is, the area for designing the depth and shape of armhole line. It is also the adjustment area at the bottom of armhole when changing the front and back garment pieces. The free area of lower limbs is the space for adjusting the sharp deviation of gluteal bottom, and it is also the space for free modeling of pattern crotch.

3.4 Design Area

The design area is the area that produces design effect, and it is the main performance area. This area can be designed into various contours. The upper body design area refers to the range from the free area to the ground; the lower bodydesign area is the range from the gluteal fold to the ground, and it is the main performance area of the beauty of the shape such as the length and width of skirts and trousers. The upper limb design area is the area where the length, fineness and shape of sleeves are designed from armpit to wrist, and the design performance area of cuffs around wrist. The lower limb design area is the area for feeling the shape when designing skirts and trousers.

IV. DYNAMIC DEFORMATION OF HUMAN BODY AND DESIGN OF CLOTHING

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RELAXATION

Relaxation refers to the activity gap between clothing and human body. From the perspective of clothing design, the state that clothing completely fits to human body is called zero relaxation.For example, underwearrequires complete fitting; the state of cutting into the body surface is negative relaxation, such as bathing suits and tight clothing; the state of leaving the body surface is positive relaxation, such as loose-fitting clothing.

According to the needs of clothing, there are the following kinds of relaxation:

(1)Relaxation required byphysiological needs and health demand: the relaxation required by physiological and health phenomena such as skin exotherm, sweating, temperature regulation, exhalation and inhalation.

(2)The relaxation required for putting on and taking off clothing: make opening in the center, armpit and cuffs of the front part and rear part of clothing can reduce or even eliminate relaxation. However, due to the three-dimensional structure of the human body, it will be difficult to put on and take off without relaxation in parts outside the opening, especially for fabrics with poor stretchability[10].

(3) Relaxation relative to body shape change: solving the body shape change caused by growth and development, food taking, pregnancy, daily life movements, sports, and work.

(4) Relaxation required by clothing varieties and styles: infant clothing, old people's clothing, school clothing, overalls, sportswear, casual clothing, pajamas, etiquette clothing, etc. There are different relaxation requirements for different uses. The same clothing will have different relaxations due to the change of fashion style in different periods.

(5) Relaxation amount required for physical properties of clothing materials: different thickness, density, weight, rigidity, flexibility and drapability of clothing materials will also lead to different relaxations.

V. RESEARCH ON THE STRUCTURE OF KEY PARTS OF CLOTHING IN HUMAN BODY

5.1 Structure of Neck and Collar

Collar is the garment shape related to the neck, mainly including collar circumference, collar and neckline. Cervical vertebra, neck muscles and subcutaneous fat affect the clothing shape. From the neck structure, it can be seen that the skin at the back collar circumferencehas little change and high stability, that is, the position of thecenter mark BNP of the collar circumference. The skin around the front collar circumferencechanges greatly, which is affected by joint movement and has poor stability. Therefore, no matter what collar shape is designed, the back is the foundation, and then the influence of the front neck movement is considered.

The stop point of the sternocleidomastoid muscle, the main muscle of neck movement, is located behind

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the left and right axes of the posterior joint of atlas, so the part with great movement is the anterior neck. This is the basic consideration of neck movement functionality. The collar that blocks the pharyngeal head, such as the high stand collar, is the most inappropriate, but it is suitable for clothing and military uniforms that restrict the movement of the neck, restrain the shaking of the body and improve the tightness of the whole body. The commonly used collar is the collar flat front part. It is both beautiful and practical, no matter from the movement characteristics of neck bending or from the view that it never interferes with the front movement of the main muscle of neck. The lapel collarshavea flat part. They are a collar type with good decoration and movement function. The front part of the shirt collar is not flat. But when wearing it, it can reduce the contact with the neck because of the opening of the front part.

5.2 Shoulders of Human Body and Shoulder of Clothing

The shoulders of human body can not only support clothing, but also increase the beauty effect of human body and clothing. Shoulders have frequent activities, with extremely wide range of movement is very wide, whichare complicatedeven in static state. Therefore, the shoulders of clothing should meet both static and dynamic requirements. The design of the shoulders of clothing is to deal with the two aspects of this contradiction reasonably.

Sen from shape and function, the muscles closest to the shoulders of clothing are trapezius and deltoid. According to the connection between trapezius and neck muscle group or subcutaneous fat deposition, various shoulder shapes are generated. The thickness of the muscle belly from the neck side to the middle of the shoulder end point is the place where gender difference and individual difference are most easily reflected. It is impossible to fill the pit formed by clavicle and head of humerus in the anterior part of deltoid muscle, so the shoulders of the front piece of clothing must be torized or receive other corresponding treatment. The lateral part of deltoid muscle is the basic part of the design of clothing shoulder shape. The back side is gentler than the front side, and there is no need for the same process as the front piece of clothing. However, some corresponding considerations are needed to make the front piece of clothing form a front shoulder-like fitting to stabilize the shoulder line and prevent the shoulder from falling down.

The skin around the shoulder is easy to slide as a whole, and the skin at the end of the shoulder slides the most. When the acromionor upper limbs move, the clothing hang up at the shoulder point, concentrating the pressure of the clothing. One of the goals of the shoulder movement function of clothing is to disperse the pressure of clothing, and the sliding function of skin can be an inspiration to solve the pressure concentration. The compressed shoulder skin slides to the neck side under the traction of clothing, playing a role in reducing the pressure of clothing.

It is very difficult to make the clothing shoulder fully adapt to the movement of human shoulder and make it move freely. There are two solutions: first, making the clothe, including the whole shoulders, completely loose; second, selecting appropriate materials and design pattern structure, studying processing methods, and reducing the resistance of shoulder point after comprehensive treatment to improve the functionality of clothing.

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5.3 The Chest and Back of Human Body and the Chest Width and Back Width of Clothing

5.3.1. The relationship between human chest and back structure and clothing

Generally, when making clothing, only the chest width line and back width line are indicated, with the upper limit being the shoulder range of the front garment piece and the lower limit being the horizontal line of the front and posterior armpit bottoms. The chest width line is roughly where the third rib connects with the sternum, and the back width line is roughly where the fifth thoracic vertebra is located.

The expansion of back width is caused by the movement of sternoclavicular joint and shoulder joint. There are roughly the following three situations:

(1) Only the sternoclavicular joint is used as the fulcrum to move without the shoulder joint movement. The upper limb droops and the shoulder position moves forward, resulting in back expansion;

(2) Only the shoulder joint moves. The drooping upper limb is lifted to the front horizontal direction, resulting in back expansion centered on the posterior armpit part;

(3) Both the sternoclavicular joint and the shoulder joint move. The upper limbs are closed and lifted up to the front and top, resulting in the greatest back expansion. The first two are slight deviations, and the third can reach the maximum deviation.

The back expansion is connected with the movement of upper limbs. When considering the movement function of clothing, the sleeves and back width must be considered comprehensively.

5.3.2 The relationship between chest and back muscles and clothing

The muscles related to the back of clothing include the middle trapezius muscle, latissimusdorsi muscle stop, a part of rhomboid muscle, infraspinatus muscle, teres major, scapula, posterior axilla, etc. The thickness of the scapula forms the protrusion of the back. The posterior armpit is the lower limit of the back width of clothing, a reference point of armhole theoretical shape, a base point for setting milk height line and a sign of arm movement deviation.

The chest of clothing is related to the pectoral muscle, breast and front armpit. Unlike complex and toric back muscles, the chest is flat. There is nothing special in the design of clothing except that the upper limbsare lifted up and the front armpit is deviated. The bulge of a woman's chest is obvious, but it is easier to handle than the back. The back of men's clothing is difficult to fit, and the shortcomings are easy to be exposed, so the focus is on the fitting of the back; women's clothing focuses on the fitting of breasts, mainly considering the shape and position of women's breasts. The shape can be described by height, width and orientation, but it is difficult to get the accuracy.

5.3.3 The relationship between chest and back shape and clothing

In the natural state of human body, the protrusion of chest is called chicken breast, and the protrusion of

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back is called convex back, which is a local antagonistic form. With the bulge of the chest, the back of the chicken breasttends to be flat, while the head and neck are somewhat straight. Because of the breast, this bulge is more obvious visually for women. With the hump of the back, the chest tends to be flat and the head and neck tends to bend forward. Male athletes' muscles are well developed. Their pectoral muscles are well developed, and their backs are well developed in the form of bulges, which can also be taken as the type of convex backs.

The counter body and arched body are based on the curvature of the spine and the position of the head and neck. With the changes of the chest and back, they show a systemic antagonistic form. Although they are also the bulge of chest and back, they are related to the movement of neck root and arm root, which has a great influence on clothing. The front of the counter body is elongated in the front part and shortened in the back part.The chest is bulged, and the arm root retreats, which makes the chest width wider and the back width narrower. Both vertical and horizontal directions should be changed, and comprehensive width is needed. Arched body type and counter body type have completely opposite changing tendency. The curvature of the spine increases. The anterior whiskers of the head and neck hasstretched back part and shortened front part.The back is bulged and the arm root moves forward. All of these lead to the widening of the back width.

The shape of the chicken chest body type and convex back body type is the same as that of the counter body and arched body type. To make the clothing fit, we should not only consider the situation of the counter body and arched body on the pattern, but also take the bugling part as the center, and increase the length, area and curved surface, so as to make clothing more fit. For the counter body and arched body types, the slope change and back and front movement should be made at the collar of the clothing. The armholes on the bust line should also be moved back and forth. On the pattern, collar socket and armhole should be set in proper position.

5.4 Upper Limbs and Sleeves

The upper limb belt is the basis of the free movement of upper limbs, and the directly related clothing part is the sleeve. The most common sleeves are fitted sleeves and raglan sleeves. The common problems of sleeves are sleeve top, armhole, overall shape of sleeves, movement function, etc. The bones related to sleeve design include scapula, clavicle, humerus and anterior carpal bone;the related joints are shoulder joints and elbow joints; the related muscles are upper limb muscles, upper arm muscles and forearm muscles.

In the design of the movement function of sleeves, the basic and necessary factors are the movement direction and the amount of movementof upper limbs. The range of movement of the arm, except that the center of the back only touches slightly, involves the whole field of front, side and top. Especially in the front, it can touch the shoulder on the other side beyond the center. In terms of clothing, it is difficult to make all the functions of sleeves have the above range of activities. Even if this range can be reached, unnecessary wrinkles will appear when the upper limbs return to the drooping state of static posture, which will damage the appearance. To get comfortable movement function, we must grasp the postures with high frequency, the most traction of clothing and the most compression in life, find out the most effective movement direction,

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and keep the balance between the body piece and the armhole. Armhole-sleeve top structure is the key point of tops structure design, which is related to the appearance stability of the garment body and the movement comfort of the sleeve body.

5.5 Lower Limbs and Trousers

Cingulummembriinferioris and lower limbs are important parts to support the human body when standing. They not only have the function of connecting the upper body, but also have a wide range of movement. They are closely related to the waist and glutealstructure, shape, waist line position, trousers crotch,etc.

For the lower body clothing, most of the bones are the connection between the trunk and the lower limbs. For the lower limbs, it not only supports trunk, but also serves as the connection. The pelvis is the base basin of the upper and lower sides, and its shape and position can not be ignored. The fundamental of trousers fitness is to grasp the pelvis. Traction and compression of trousers are produced because the structure of trousers cannot follow the clever changes of femoral joints and knee joints. To design trousers reasonably, we must know the structure and movements of femoral joints and knee joints.

Generally, there are three ways to design the movement function of trousers. First, cutting the increment, which is also the most standard method. The gluteal circumference line is cut to find out the effective space. Second, increasing the number of scattered darts. Two darts at the side seam are taken to get effective space at the waist. Third, increasing the number of darts in dart and switching lines. The third method can achieve both movement function and fitness. The excess part at the knee socket is removed. To effectively make the knee bend shape, the back seam line is set and a large arc is made at the hip. Besides, a dart at the side seam is taken to adapt to the foot backward movement, and it is used to obtain effective space.

By studying the dynamic characteristics of human body, it can be seen that the study of human body dynamic deformation is an important link in the relationship between human body motion state and clothing deformation. The design and manufacture of clothing must be done according to the characteristics of human body. We can ensure the fitness of clothing only by studying the law of skin deformation during the movement of human body according to the changes of different parts.

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