Electromyographic study of the dynamic sitting position suitable for dentists

The classic sitting position, adopted by all dentists, has an iatrogenic (or accidentally harmful) effect on the spinal column. Dynamic sitting positions appear to be less iatrogenic. One of the chairs offered to us most recently is the Bambach Saddle Seat. Using global electromyography, we studied the muscular activity that it causes and compared it to that required by the classic sitting position. The subjects in this experiment were 18 dentists who simulated conservatory dental work on a lower premolar. The muscles we examined were the trapezium, the large right-hand abdominal muscle, the spinal muscles, and the quadriceps. The results obtained showed a slightly superior muscular activity on this chair, principally in the dorsal muscles, but no radical change in the posture compared with the classic sitting position. The higher sitting position of this chair, the stability of its scat, and its great mobility appears to be less iatrogenic than other sitting positions.

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Figure 1: a dynamic sitting position on a Bambach Saddle Seat

In our 20th century/ the sitting position has become the general working position, for school children/ students, secretaries, and even manual labourers – including dental surgeons. It was adopted by dentists in the 1960s, and was regarded as progress when compared with the standing position. Nevertheless, this sitting position is the cause of vertebral pathologies, most frequently in the lumbar region, Rhuematological studies have demonstrated that maximum pressure is exerted an the vertebral discs: 100 kilos in the case of a stated man weighing 70 kilos (Nachemson, 1975). Inclining the seat changes the pressure; a horizontal seat, the one used most often, places a pressure on the vertebral discs far greater than that exerted when the seat is

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tilted at an angle of 15° (Leiong etal., 1988). These rheumatological studies led us to study and compare two sitting positions available to the dentist:

• the classic sitting position
• a dynamic sitting position on a Bambach Saddle Seat (Fig. 1).

We carried out an electromyographic examination on the same subjects, first in the one posture and then in the other, under the same working conditions.

Materials and method

The experiment was carried out using global integrated electromyography with an Alvar Reega XVI computer and a 4-channel Aivar integrator. The electrical potential thus derived is measured for a period of 10 seconds, and readings taken in microvolts. The derivation electrodes are rectangular, made of stainless steel, and fixed, at intervals of 2 cm, to the skin which had previously been shaved.

The muscles under examination should meet two criteria:

• they should have a superficial anatomic position, so as to permit global electromyography;

• they should play an important part in the sitting position.

We registered the trapezium, spinal, and great dorsal muscles, the large right-hand abdominal muscle, and the quadriceps.

• The trapezium muscle is triangular in shape, and stretches from the back of the neck to the upper part of the back. its job is to maintain the position of the head and to raise the arms.

• The, spinal great dorsal, and abdominal muscles stabilise the spinal column in a variable manner, depending on the inclination of the breast. The large right-hand, abdominal muscle can be electromyographically silent when the subject is in a resting position (Depreux Kapandji).

• The quadriceps muscle provides for the mobility of the leg and gives a certain muscular tone, depending on the individual's posture.

The subjects of this experiment were 18 dentists aged from 31 to 59 years, with an average age of 44.7 years. They had all worked many, if not to say very many, years in dental clinics. Their average height was 1.75 metres and their average weight 73,29kilos (see Table 1).

We asked them to simulate working on one lower premolar (No. 34), which is work that normally follows three successive phases: anaesthesia, working on the cavity, inserting amalgam. Four actions were taken during the course of each phase, and three actions in the resting position. This simulated work was repeated in an identical manner in the two different postures, and during the same session. We studied 30 actions in each individual, or 550 in total.

Table I – The Subjects of the Study

	Height (m)	Weight (kg)	Age	Sex
1	1,72	68	55	M
2	1,86	80	45	M
3	1,63	57	35	F
4	1,70	51	36	F
5	1,77	75	39	M
6	1,83	84	52	M
7	1,83	73	47	M
8	1,76	80	34	M
9	1,79	91	52	M
10	1,80	80	59	M
11	1,70	69	53	M
12	1,82	97	33	M
13	1,68	72	50	M
14	1,80	75	31	M
15	1,76	72	35	M
16	1,78	70	53	M
17	1,65	53	40	F
18	1,72	72	57	M
Average	1,75	73,29	44,7	

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The two sitting positions studied were the classic and dynamic positions.

The classic sitting position was that resulting from sitting on a chair with a low, horizontal seat (46 cm from the floor). The movements of the hip and the knee resulted in an angle of 90° and the feet were flat on the floor.

The dynamic sitting position (defined by Reissner) is higher - 65 to 80 cm from the floor - and the movements of the hip and the knee resulted in an angle of 130° once again, the feet rested flat an the floor. The chair tested was the Bambach Saddle Seat; as its name suggests, its seat takes the form of a horse-saddle, which makes the subject sit with his or her legs slightly apart. The seat can be tilted forwards, and adjusted in height to suit the size of the individual. The seat can swivel on its axis, and the chair itself is mounted on casters, which gives it plenty of mobility. The feet rest on the floor.

Results

All in all, the electromyographic results reveal greater muscular activity on the dynamic chair than on the "classic" chair. However, this overall difference is made up of slight variations from one individual and one muscle to another.

in the rest position, 8 subjects displayed greater activity in 4 muscles on the dynamic chair and 5 other subjects displayed greater activity in 3 muscles.

Working, 10 subjects out of 18 displayed greater activity in 4 muscles.

The other individuals showed varying results, depending on the muscle and the exercise.

Subjects No. 17 (female, 40] and No. 2 (male, 45) displayed greater activity in 4 muscles (Tables II and III).

Subject No. 9 (male, 52) displayed greater [electrical) potential in the trapezium, quadriceps, and dorsal muscles, but less in the abdominal muscles, which seem to be relaxed as a result of a higher sitting position. Also, the variations in activity in this male subject were far weaker than in Subject No. 2 (Table IV).

If one looks at the results for each muscle in subjects when using the Bambach saddle Seat:

• The quadriceps muscle displayed greater potential in 14 individuals, both at rest and when working. A higher sitting position with more weight resting on the floor activates this muscle, which is responsible for positioning the leg and helping to maintain the position of the pelvis;

• The trapezium muscle likewise displayed greater potential in 13 individuals at rest and 17 at work. This muscle plays an important role in carrying the head and the neck, and in raising the arm, it

Table II Subject No. 17

	Abdominal			Spinal Muscle		
	Convent.	Saddle Seat	% var. pot.	Convent.	Saddle Seat	% var. pot
Rest	127	100	-27,0%	658	707	6,9%
	107	110	2,7%	613	704	12.9%
	89	97	8,2%	663	702	5,6%
Average	108	102	-5,3%	645	704	8.5%
Preparation	91	166	45,2%	625	1027	39,1%
	89	207	57,0%	654	1028	36.4%
	81	162	50,0%	645	708	8,9%
	194	130	-49,2%	650	701	7.3%
Average	114	166	25,7%	644	866	22,9%
Cavity	95	163	41,7%	663	718	7,7%
	98	142	31,0%	660	717	7,9%
	93	120	22,5%	660	713	7.4%
	97	117	17.1%	663	713	7.0%
Average	96	136	28,1%	662	715	7.5%
Amalgam	100	111	9,9%	675	706	4.4%
	101	94	-7,4%	679	706	3,8%
	102	95	-7,4%	677	706	4,1%
	105	124	15,3%	678	717	5.4%
Average	102	106	2,6%	677	709	4,4%

The values shown are in millivolts

Table III – Subject No. 2

	Abdominal			Spinal Muscle		
	Convent.	Saddle Seat	% var. pot.	Convent.	Saddle Seat	% var. pot.
Rest	177	226	21,7%	491	552	11,1%
	179	225	20,4%	497	547	9,1%
	177	223	20,6%	499	547	8,8%
Average	178	225	20,9%	496	549	9.7%
Preparation	197	329	40,1%	495	742	33,3%
	196	329	40,4%	496	724	31.5%
	195	327	40,4%	498	709	29,8 %
	194	319	39,2%	498	794	37,3 %
Average	96	326	40,0%	497	742	33,0%
Cavity	215	296	27,4%	540	637	15,2%
	215	296	27.4%	540	665	18.8%
	214	279	23,3%	544	634	14,2%
	213	295	25,3%	540	647	16,5%
Average	214	289	25,8%	541	646	16,2%
Amalgam	217	280	22,5%	566	651	13,1%
	212	266	20,3%	549	624	12,0%
	221	276	19,9%	572	646	11,5%
	219	274	20,1%	571	646	11.6%
Average	217	274	20,7%	565	642	12,0%

The values shown are in millivolts

seems only logical that it should be more active when the back is held in a more vertical posture.

The dorsal, spinal and great dorsal muscles displayed greater potential in 13 subjects at rest and 16 subjects at work. These muscles play a vital role in holding the spinal column erect. A higher and straighter posture stimulates their activity. The musculature of the back is regarded by rheumatologists as a positive element in preventing vertebral pathologies (Table V).

On the abdominal muscles, at rest, 10 subjects presented an increase in potential, and 8 subjects less potential. At work, on the other hand, 13 subjects showed an increase in potential and 5 a decrease. The increased activity at work would express both a slight forward inclination of the trunk while carrying out dental work and the tension which the effort and precision of this work requires.

The abdominal muscles are the ones that generally display weak potential compared with those seen in the other muscles under examination. This might be partly due to the adipose layer which forms a screen between the muscle band and the electrodes on the surface. We put up this hypothesis with regard to subject No. 9 (Table IV), but we cannot completely substantiate it because we also registered very weak potential in the abdominal muscles of those subjects, who were rather younger and slimmer, in whom no adipose layer is discernible. We consider that the shape of the seat of this chair is the reason for this relaxation of the abdominal muscles, and will come back to this point in the discussion.

Discussion

The classic sitting position is considered to be more favourable for precision work because it immobilises important segments of the body (Laville, 1975). However, other authors have described it as being highly iatrogenic for the back.

Mandal (1985) thought that this position, imposed on schoolchildren, ruins their backs from childhood onwards, because, chairs and desks in schools are too low. He recommended that seat heights should be between 49,5 and 60 cm. The same Mandal (1987), conducting an experiment on Danish bank employees, observed that they chose seats with an average height of 54,3 cm for the greatest comfort (in the case of individuals between 1,58 and 1,75 metres in height). This seat height is in line with the height our subjects also judged be the most comfortable for the saddle seat, and they were considerably taller than in the Danish experiment. The degree of flex of the hip and the knee determines the pressures exercised on the lumbar marrow and the pubic region (Bridger, 1991). On this basis, a very vertical sitting position, such as that observed by Mandal in the Pharaohs and the Victorian England of the 19th century, is healthy for the back.

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In an earlier study, we compared a classic sitting position with a kneeling position (Yerkindere et al., 1992 and 1993). Sitting in a kneeling position, subjects displayed a complete loss of electrical potential in the same muscles and under identical experimental conditions to than in this study.

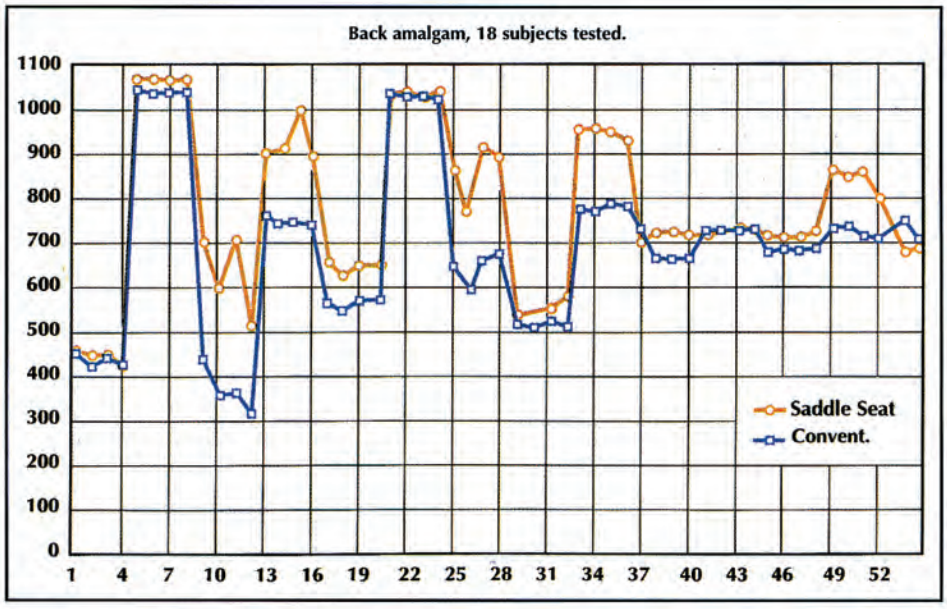
When the subject is sitting on a chair that allows a kneeling position, the pelvis and the legs are supported and the weight of the body rests partly on the iliac crests and partly on the knees themselves; there is no flat contact with the floor, and the legs have no location work to do. The sitting position being higher and more vertical on a "kneeling" chair than on. a conventional one appears to be a more favour able physiological element. Nevertheless, the considerable reduction in muscular electrical potential and the absence of contact with the floor seem to be negative elements. The relaxation of the muscles of the back is in contradiction with the recommendations of rheumatologists for preventing discal pathologies.

The great novelty of the Bambach Saddle Seat appears to be the shape of its seat (Fig. 1), being concave at the rear and convex at the front. The pelvis thus do not rest solely on two unstable points, the sciatic protuberances (iscial tuberosities), as is the case when the subject is sitting on a conventional chair or on any flat

Table IV – Subject No 9

	Abdominal			Spinal Muscle		
	Convent.	Saddle Seat	% var. pot.	Convent.	Saddle Seat	% var. pot.
Rest	1,00	0,01	-9900,0%	446	453	1,5%
	1,00	0,01	-9900,0%	443	452	2,0%
	0,01	1,00	99,0%	444	449	1,1%
Average	0,67	0,34	-6567,0%	444	451	1,5%
Preparation	0,01	1,00	99,0%	450	450	0,0%
	1,00	1,00	0,0%	449	450	0,2%
	0,01	0,01	0,0%	443	436	1,6%
	0,41	0,60	31,7%	445	452	1,5%
Average	0,36	0,65	32,7%	447	447	0,0%
Cavity	0,01	1,00	99,0%	1,00	454	99,8%
	1,00	0,10	-900,0%	0,01	453	100,0%
	0,01	1,00	99,0%	1,00	454	99,8%
	0,01	1,00	99,0%	0,01	454	100,0%
Average	0.26	0,78	-150,8%	0,51	454	99,9%
Amalgam	0,01	0,01	0,00%	0,01	405,00	100,0%
	0,01	0,01	0,00%	0,01	450,00	100,0%
	1,00	0,01	-9900,0%	1,00	436,00	99,8%
	0,01	0,01	0,00%	0,01	452,00	100,00%
Average	0,26	0,01	-2475,0%	0,26	447,00	99,9%

Values are expressed in millivolts



plane; in this instance it is resting on a large surface, involving the upper and inner parts of the thighs. The pelvis is thus constantly maintained in a vertical position, and cannot rock to and fro.

This chair dynamises the muscles of the pelvis and the thighs, and encourages and facilitates considerable mobility of the dentist.

The ideal position, one which would not cause any inconvenience at all, probably does not exist. However, the conventional sitting position has proved, ever since it started to be used, that it is very largely the cause of pathologies, sometimes severe ones, in the vertebral column. The dynamic sitting position described above twenty years ago by Reissner (Verkindere et al., 1994) appears to be a less iatrogenic posture, and the dynamic sitting position on the Bambach Saddle Seat seems to represent a way of avoiding these inconveniences. Because it entails moderate muscular activity, it helps the user to maintain a supple musculature around the spinal column, The sturdy support provided by its shape helps the user to maintain this posture easily. The more vertical position of the trunk and the legs is more favourable for the main physiological functions. Positioning the feet on the floor is comfortable, and psychologically reassuring, and constantly teaches the individual the right kinesiological lessons.

It is up to each of us to adapt our working conditions to suit our personal morphology, as every dentist should now be aware in 1997 (Champleboux, 1997).

Article submitted on 17th November 1997.
Accepted for publication on 24th November 1997.

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